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FAKE NEWS AND INFORMING SCIENCE

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ABSTRACT

Aim/Purpose	The goal of the paper is to consider how the informing phenomenon referred to as “fake news” can be characterized using existing informing science conceptual schemes.
Background	A brief review of articles relating to fake news is presented after which potential implications under a variety of informing science frameworks are considered.
Methodology	Conceptual synthesis.
Contribution	Informing science appears to offer a unique perspective on the fake news phenomenon.
Findings	Many aspects of fake news seem consistent with complexity-based conceptual schemes in which its potential for establishing or reinforcing group membership outweighs its factual informing value.
Recommendations for Practitioners	The analysis suggests that conventional approaches to combatting fake news, such as reliance on fact checking, may prove largely ineffective because they fail to address the underlying motivation for absorbing and creating fake news.
Recommendations for Researchers	Acceptance of fake news may be framed as an element of a broader information seeking strategy independent of the message it conveys.
Impact on Society	The societal impact of believing of fake news may prove to be less important than its long term impact on the perceived reliability of informing channels.
Future Research	A broad array of research questions warranting further investigation are posed.
Keywords	fake news, informing science, extrinsic complexity, conceptual scheme

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INTRODUCTION

For more than a decade, the processes of misinforming and disinforming have been identified as a research priority for the informing science transdiscipline (Cohen, 2009). There can be no better example of these phenomena than the recent explosion in what is popularly referred to as “fake news”. Driven by recent events, particularly the U.S. presidential election of 2016, journalists, elected officials and academics have all warned of the potentially dire consequences of the widespread acceptance of the phony news items that spread across the Internet with remarkable rapidity. The very direction of a nation—as determined by whom we elect—may be determined by news items that are entirely untrue (Blake, 2018).

For those of us in the teaching profession, the evident widespread acceptance and influence of fake news present something of a paradox. Given how difficult it seems to be to get our students to read and absorb a simple syllabus, how can it be that improbable content spread over a channel whose trustworthiness is already in doubt (i.e., social networks) can exert such a powerful influence?

Because fake news has so many aspects—e.g., information systems, legal, journalistic, philosophical, educational—an interdisciplinary approach is required to understand and combat it (Lazer et al., 2018). As a transdiscipline focused on improving our understanding of how information flows between informers and clients (Cohen, 1999), informing science is well positioned to participate in this effort.

The goal of the present paper is to identify a variety of conceptual schemes that have emerged within informing science and consider how they might be applied to fake news. The paper begins with a brief overview of fake news. This is followed presentations of various models identified in a two-volume survey of informing science (Gill, 2015a, 2015b). The models presented include those dealing with extrinsic (i.e., environmental) complexity, informing transitions, and individual resonance. The potential implications for informing science research into fake news are discussed, and questions that may warrant future research are raised. The paper then concludes by describing what current informing science may already be telling us about fake news, its spread and its influence.

WHAT IS FAKE NEWS?

Although the use of the term fake news has spiked in recent years (see Figure 1), misleading news items have existed throughout human history under names such as propaganda (Habgood-Coote, 2018). For the purposes of this paper, however, we will concern ourselves mainly with its manifestation over Internet-based channels such as search and social media.

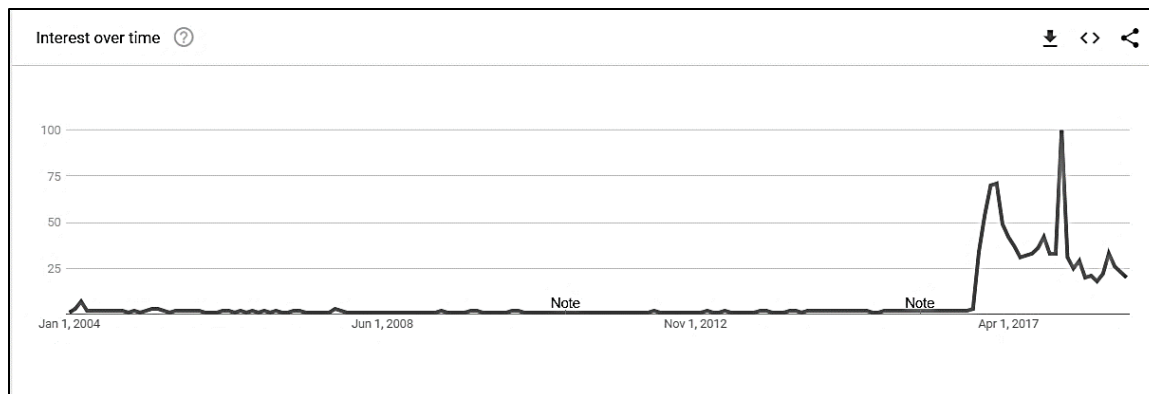


Figure 1. Google trends chart of searches for the term “fake news” showing frequency of search per day over time

The sudden jump of interest shown in Figure 1 is largely a result of speculation regarding the role it played in the 2016 U.S. presidential election. A number of other examples, such as Russian involvement in the Ukraine (e.g., Khaldarova & Pantti, 2016; Haigh, Haigh, & Kozak, 2018) and Brexit-related interference (e.g., Farkas & Schou, 2018; Peters, 2018; Raskin et al., 2017; Roozenbeek & van der Linden, 2018), are also commonly mentioned.

FAKE NEWS VS SATIRE

Over the past several years, the usage of fake news has changed. Prior to the 2016 election, fake news was most commonly used to describe intentionally satirical content, such as the late-night *The Daily Show* in the U.S. (e.g., Borden & Tew, 2007; Costera Meijer, 2007; Brewer, Young, & Morreale, 2013; Balmas, 2014) and the web-based news site *The Onion* (Reilly, 2012; Rubin, Chen, & Conroy, 2015; Rubin, Conroy, Chen, & Cornwell, 2016; Berkowitz & Swartz, 2016). Here, the concern was mainly that individuals, particularly young people, were using satirical content as their principal source of news (e.g., Marchi, 2012). Since that time, however, the intent to mislead readers appears more commonly in fake news definitions as an explicit or implicit requirement (e.g., Alcott & Gentzkow, 2017; Chen, Conroy, & Rubin, 2015; Bakir & McStay, 2018; Guo & Vargo, 2018; Lazer et al., 2018; Tandon, Lim, & Ling, 2018). Interestingly, however, it has been observed that what we now call fake news often takes a form that mimics that of earlier satire (e.g., Horne & Adali, 2017).

PROTOCOL

From a research perspective, the sudden burst of interest in fake news provides both benefits and drawbacks. On the positive side, recent coverage of the topic has been high. For the purposes of the present paper, the top 100 listings in Google Scholar containing the term “fake news” were examined. Of these, under half were selected as being relevant based upon their focus, which had to be upon fake news rather than being an incidental reference to the term or a reference to satirical news. These references were augmented by relevant citations identified within each article, producing a total of 52 articles examined. Of the 52, more than 60% were from the past two years (2017 and 2018) and more than three quarters were from the past three years (2016-2018). On the negative side, a substantial number of these articles were from sources which had not yet been subject to peer review, such as arXiv (4), SSRN (3), newspapers and radio interviews (3), and websites (6). For this reason, it is plausible that some of the fake news articles cited might, themselves, represent “fake research”. In examining the papers, however, the author did not detect any major outliers with respect to the themes discussed or the conclusions presented. It is therefore unlikely that any individual article exerted undue influence on the analysis presented in this paper.

LITERATURE SUMMARY

To develop a summary, the author coded the 52 articles identified based on their core content. Based on this coding, seven themes of interest consistently emerged. These were classified as follows:

1. *Definition*: Discussing how fake news should be defined.
2. *Transmission*: Dealing with the mechanisms through which fake news is propagated.
3. *Detection*: Dealing with the ability to distinguish fake news from other valid content in a particular channel.
4. *Incentives*: Dealing with the *informer's* motivation to create fake news
5. *Motivation*: Dealing with *consumer's* motivation to digest (be informed by) fake news
6. *Impact*: Dealing with the individual or societal impact of fake news
7. *Prevention*: Dealing with mechanisms for preventing the transmission of fake news or reducing its impact.

Figure 2 shows the relative frequency of article classification. A discussion of key findings for each theme follows.

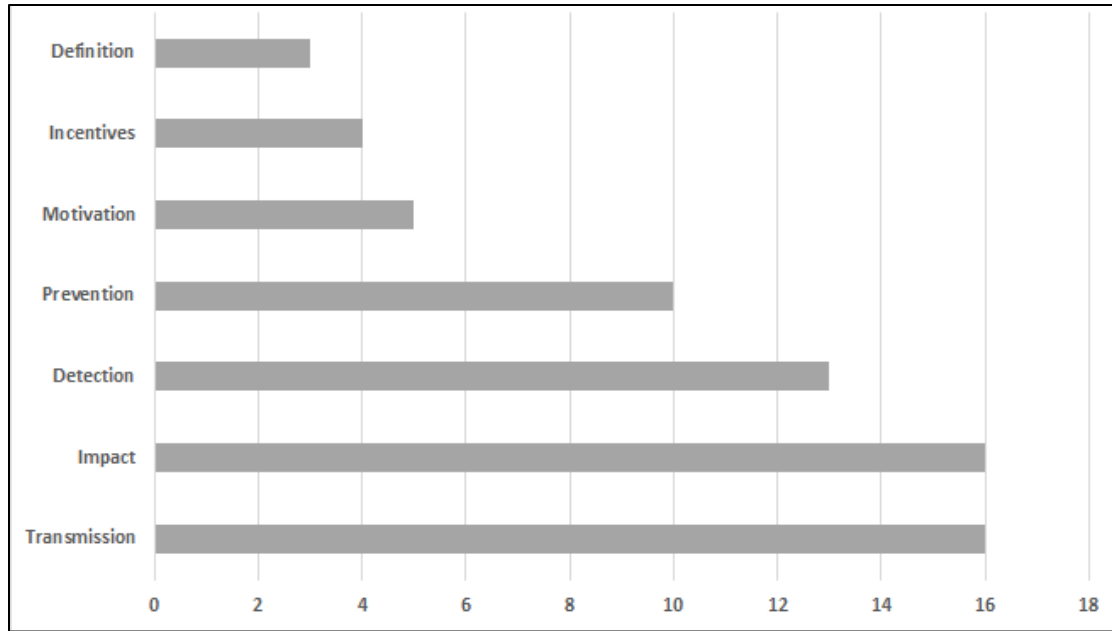


Figure 2. Counts of classification of fake news articles in review (articles may appear in more than one category)

Definition

The use of the term fake news has not received universal approval. Researchers have noted that it tends to be ambiguous in the way it is used and can describe many different phenomena; for example (Habgood-Coote, 2018, p. 12):

The writers who use ‘fake news’ and ‘post-truth’ are concerned with a massively heterogeneous set of issues, including but not limited to:

- the effects of digital capitalism on the internet;
- the quality of information on social media sites;
- the epistemic quality of news provision;
- biases in news provision;
- the quality of public discourse;
- fragmentation and polarisation of public discourse; and
- misplaced trust in news sources.

Others have argued that its role as a political signifier is more significant than its veracity or lack thereof; for example (Farkas & Schou, 2018, p. 309):

any attempt to categorise, classify and demarcate between “fake” and “true” must be a deeply political practice, whether conducted from the context of journalism or academic interventions. It is part of larger political struggles to define the current shape and modality of contemporary society. Future research might begin to unpack and further develop this politics of falsehood by attending to how conceptions of “fake news” and “factuality” serve to carve out the stakes of current political crises.

For the purposes of the present paper, these debates become relevant as we consider the motivations to accept fake news as real. For the present, however, it makes sense to adopt a definition that is consistent with the most widespread current usage, as found by the author over the course of the review;

specifically, a definition proposed by Alcott & Gentzkow (2017, p. 211): *news articles that are intentionally and verifiably false, and could mislead readers*

Transmission

One of the most commonly examined topics in the literature is the manner through which fake news is transmitted. Of greatest interest here was the primacy of social networks, particularly Facebook, over other channels (including Twitter; Silverman & Singer-Vine, 2016). Among the key findings:

- Social networks tend to produce ideologically separated, homophilous groups that tend to limit the number of perspectives available to the individual (Alcott & Gentzkow, 2017; Mihailidis & Viotty, 2017), sometimes referred to as a “filter bubble” (Bakir & McStay, 2018).
- Through processes such as liking and retweeting, these networks produce an effect referred to as an “echo chamber” (Kucharski, 2016; Lazer et al. 2017; Shao, Ciampaglia, Varol, Flammini, & Menczer, 2017; Guess, Nyhan, & Reifler, 2018; Kucharski, 2016) that reinforces beliefs.
- That the emergence of “social bots”—automated routines that mimic human users and serve to make messages spread more quickly—have amplified the fake news problem (Lazer et al., 2017; Shao et al., 2017; Shu, Sliva, Wang, Tang, & Liu, 2017; Bakir & McStay, 2018; Tandoc et al., 2018).
- Implausibility does not seem to prevent the spread of fake news (Silverman, 2016). A commonly cited example of this was ‘pizzagate’, where fake news that Hillary Clinton was running a child trafficking ring out of a Washington, D.C. pizza parlor was widely disseminated and caused one believer to arrive at the restaurant with a gun intending to free the captives (Kang, 2016).
- That fake news transmission patterns exhibit similarities to those of infectious diseases (Kucharski, 2016; Roozenbeek & van der Linden, 2018).

Detection

Fake news detection was another recurring topic. It could be broken down into two subtopics: its detection by machine and its detection by clients. With respect to automated detection, key findings included the following:

- With a training set that identifies who “liked” real and fake news on Facebook, a high degree of accuracy in classifying fake news was obtained (Tacchini, Ballarin, Della Vedova, Moret, & de Alfaro, 2017). More generally, authentication of identity can be a powerful tool in identifying fake news sites (Conroy, Rubin, & Chen, 2015).
- Linguistic patterns can be helpful in distinguishing fake from real links (Chen et al., 2015; Rashkin, Choi, Jang, Volkova, & Choi, 2017). Of note is the similarity to patterns used in satire (Horne & Adali, 2017; Potthast, Kiesel, Reinartz, Bevendorff, & Stein, 2017).
- The task of automated detection may need to be broken down based upon the type of fake news being detected. One proposed breakdown is “a) serious fabrications (uncovered in mainstream or participant media, yellow press or tabloids); b) large-scale hoaxes; c) humorous fakes (news satire, parody, game shows).” (Rubin et al., 2015, p. 86)

With respect to human detection, the findings were not so optimistic; for example:

- Students consistently demonstrated weakness in detecting fake news. “In exercise after exercise, the researchers were “shocked” — their word, not ours — by how many students failed to effectively evaluate the credibility of that information.” (Domonoske, 2016). These findings applied all the way from middle-school to Stanford undergraduates.

- Individuals who were major users of Facebook were particularly prone to believing fake news headlines (Silverman & Singer-Vine, 2016).
- Survey respondents were not confident in their ability to distinguish between true and false news (Newman, Fletcher, Kalogeropoulos, Levy, & Nielsen, 2017).

Incentives

With respect to incentives to produce fake news, the most significant reported motivations were financial and political; for example:

- Using fake news as “click bait” can lead to advertising revenue (e.g., Chen et al., 2015; Sydell, 2016; Mustafaraj & Metaxes, 2017; Tandoc et al., 2018).
- The goal of using fake news for political purposes was widely acknowledged, including Russia’s actions in the Ukraine (Khaldarova & Pantti, 2016). In the U.S. 2016 election, one report estimated that “around 19 million bot accounts tweeted in support of either Trump or Clinton in the week leading up to election day” (Shu et al., 2017).

Motivation

One of the most interesting set of findings and speculations from the articles studied involved the motivations of consumers (clients in informing science terminology) to accept fake news reports. Because few of us, aside from major government, financial and industry leaders, are situated so as to benefit directly from the information conveyed in the news, other motivations must be in place. Some proposed motivations include the following:

Consumers receive utility through two channels. First, they want to know the truth. In our model, consumers must choose an action, which could represent advocating or voting for a candidate, and they receive private benefits if they choose the candidate they would prefer if they were fully informed. Second, consumers may derive psychological utility from seeing reports that are consistent with their priors. Consumers choose the firms from which they will consume news in order to maximize their own expected utility. They then use the content of the news reports they have consumed to form a posterior about the state of the world. Thus, consumers face a tradeoff: they have a private incentive to consume precise and unbiased news, but they also receive psychological utility from confirmatory news (Alcott & Gentzkow, 2017, p. 218)

These two motivations may be characterized as *rational* (anticipating the knowledge will produce a tangible benefit) and *psychological* (a predisposition towards confirmation, sometimes referred to as confirmation bias (Lazer et al., 2018)). Another motivation may be characterized as *social*. For example:

Young people indicate that they are interested in particular in shocking, bizarre, funny and abnormal events. Odd humor and strange rumors attract their attention. The particular relevance of such information to them is that it supplies them with conversation topics. Information has to be new, fun, exciting, odd or harsh; a program has to have some ingredient that impresses, surprises, amazes or shocks them. After all, regular topics provide little incentive for starting a chat with friends. Young people find the informative function of knowledge to be subordinate to its communicative function (Costera Meijer, 2007, p. 102).

Another example of the social motivation can be found in acknowledgement through positive feedback:

When citizens see themselves as active proponents for their personal worldviews and values, and have easy means to share them, they will likely do so and be reaffirmed by feedback from peers through shares, likes, and retweets. (Mihailidis & Viotty, 2017, p. 450)

Impact

The potential impact of fake news is reported at both the individual and societal level. At the individual level:

- Exposure to a topic as fake news appears to increase the individual's receptivity to the topic when encountered in real news (Brewer et al., 2013).
- Capacity to reason analytically, as measured by the Cognitive Reflection Test (CRT), improves the individual's ability to discern that a news item was fake (Pennycook & Rand, 2018). Somewhat unexpectedly, this ability did not seem to be tied to whether the news item was ideologically consistent with the individual's personal views. This also supports assertions that the education system's failure to teach critical reasoning to students is at the root of the fake news problem (e.g., Berghel, 2017).
- Repeated exposure to a given fake news story appears to make it more credible even in the face of evidence to the contrary (Polage, 2012; Wardle, 2017; Pennycook, Cannon, & Rand, 2018).

With respect to societal impact:

- There remains considerable uncertainty regarding the actual impact of fake news on a societal level. For example, given that segregated social networks tend to share only those stories consistent with prevailing views, some studies seem to discount the likelihood that fake news impacted the outcome of the 2016 U.S. presidential election (e.g., "the larger this selective exposure, the smaller the impact we would expect of fake news on vote shares" (Alcott & Gentzkow, 2017, p. 232)). On the other hand, at least one study suggests that fake news may have been the deciding factor in that election (Blake, 2018). Doubts have also been raised about the actual level of impact of fake news in Europe, specifically Italy and France (Fletcher, Cornia, Graves, & Nielsen, 2018).
- Concerns have been raised regarding how fake news may affect societal attitudes and sentiments (e.g., "The fake news situation is socially and democratically problematic on three fronts: (1) its production of wrongly informed citizens, that (2) are likely to stay wrongly informed in echo chambers and (3) be emotionally antagonised or outraged given the affective and provocative nature of much fake news" (Bakir & McStay, 2018, p. 159)).
- Societal collective memories engendered by fake news may produce false memories (Spinny, 2017). This phenomenon appears to be similar to that resulting from repeated exposure at the individual level.
- Journalists complain that the prevalence of fake news undermines confidence in fact-based news organizations (Lischka, 2017). On the other hand, the impact of and threat posed by fake news may have been overstated by journalists as a consequence of "moral panic" (e.g., "Although fake news resembles professional journalism in only an artificial or surface way, the threat accorded to it by journalists reflects a fear that digital media channels only pollute the media environment, with an irresistible psychological and emotional draw that runs counter to standard objective news. In this sense, the discourse above shows great disdain for fake news, but also larger fears about the democratized access to the information environment made possible by digital media." (Carlson, 2018, p. 14)).
- Even where fake news is not deemed credible by a group, it can impact that group's agenda by forcing a response (Vargo, Guo, & Amazeen, 2018).

Prevention

Often associated with articles that relate to detection or transmission, a variety of ideas for preventing the spread of fake news have been proposed. These include:

- To the extent that fake news spreads like a disease, a process paralleling inoculation—whereby individuals are exposed to fake news in a controlled environment then convinced that it is not credible—may reduce susceptibility (Kucharski, 2016; Roozenbeck & van der Linden, 2018).
- Different types of fake news may demand different types of countermeasures (Khaldarova & Pantii, 2016; Haigh et al., 2018).
- Attaching warning labels to some fake news items may have the unintended consequence of increasing our vulnerability to fake news that is missing the label (Pennycook & Rand, 2019).
- Given the economic and political incentives for supplying fake news, any attempt to prevent it must take place on the demand-side (Berghel, 2017).
- Because fake news both thrives on the sensational and tends to feed off fact-based media, its impact could be reduced if the fact-based media placed less emphasis on sensational stories—including stories about fake news itself (Guo & Vargo, 2018).

APPLYING INFORMING SCIENCE TO FAKE NEWS

We now consider how various conceptual schemes (i.e., models and frameworks (Gill, 2011)) that have been incorporated into informing science that appeared to be potentially applicable to the topic of fake news. The specific models to be considered are as follows:

- *Rugged landscape*: A client-model that treats informing as a search for higher fitness on the part of a client.
- *Preferred informing sources*: A variation of a previous client-side model that looks at how the environment may impact our preferred information sources.
- *Informing transition*: A client-side model that looks at the process of being informed as involving three different types of complexity: experienced, intrinsic and extrinsic.
- *Preferred informing channel*: An informer-side model that looks at preferred channels in terms of diversity of clients and possible informing outcomes.
- *Single client resonance*: A client-side model that looks at the filters (e.g., attention, information, cognitive, preference, motivational, visceral) that communications must pass through in order to achieve intended informing.

RUGGED LANDSCAPE

The rugged landscape model is based upon models that initially emerged in evolutionary biology (e.g., Kauffman, 1993). The basic idea of the model is that the fitness, a measure of the desirability/survivability of a state, is a function of the attributes of that state. For the purposes of informing science, the fitness concept can be applied more broadly. For example, the fitness of a student's answers to a multiple-choice test would be a function of the specific answers given for each question; the fitness of a recipe would be a function of its ingredients and preparation steps.

The relationship between fitness and the attributes that determine it necessarily exists on a continuum between two extremes. At one end, we have decomposable. Here, each attribute contributes to fitness independently—fitness therefore becomes the sum of the individual contributions of each attribute. The multiple-choice example would typically fall into this category, with each response contributing a certain number of points if correct, 0 points otherwise. The test's "fitness" is then scored by adding up the points for all questions. At the other extreme, maximal real-world complexity, individual attributes contribute to complexity only through interaction with other attributes. Such a landscape necessarily has very many local fitness peaks (i.e., states where all adjacent states reachable by changing the value of a single attribute have lower fitness than the original state).

As the fitness/attribute relationship tends towards higher values of real-world complexity, we move towards a rugged landscape—one where interactions between attributes dominate the independent

contributions of attributes towards fitness. The recipes in a cookbook provide an example. At least in the authoring chef's mind, each recipe represents a local fitness peak; if the chef thought an incremental change would improve the recipe, he or she would have modified the recipe to incorporate that change.

Another issue presented by the rugged fitness landscape model is an agent's inability to assess fitness. True fitness manifests itself through long term survival, whether it be the fitness of an organism or the fitness of an idea. Such fitness cannot be determined in the short term; it can only be estimated (Gill, 2010). For this reason, an individual needs to use proxies for fitness. One such proxy is the economic concept of utility, the basis upon which economic choices are made. Evolutionary economists postulate that, over the long term, our individual utility functions evolve so that our preferences are aligned with the long term survival of the species (Gandolfi, Gandolfi, & Barash, 2002). By this logic, the ruggedness of the fitness landscape should be mirrored in the shape of our utility preferences.

The challenge presented by high levels of real-world complexity is that any underlying theory that describes the landscape would be too large to compile and too unwieldy to communicate (Gill, 2011). For this reason, to increase fitness on such a landscape, heuristics must be employed. One particularly powerful heuristic that an agent on such a landscape can employ involves looking for self-similar agents and imitating them (Gill, 2012). Self-similarity is critical here, since mimicking an agent that occupies a different peak by changing a single attribute will necessarily move the imitating agent into a valley between the two peaks.

Since choosing to believe a specific news item would represent an incremental transition from one state to another, the rugged landscape model would make several predictions. Specifically, the likelihood that a fake news item will be believed by an individual:

1. Will be greater when received in channels dominated by self-similar individuals than for channels populated by individuals of greater diversity or whose membership is uncertain.
2. Will be greater when transmitted by self-similar individuals perceived to be of higher fitness.
3. Will be greater as the perceived ruggedness of the environment grows.

There seems to be some evidence that these predictions are consistent with preliminary findings related to fake news. With respect to Prediction 1, Facebook has been characterized as being dominated by segregated homophilous (i.e., self-similar) ideological groups (Alcott & Gentzkow, 2017). A study found that it also seemed to be the preferred vector for fake news items:

Facebook was among the three previous sites visited by respondents in the prior thirty seconds for 22.1% of the articles from fake news websites we observe in our web data. By contrast, Facebook appears in the comparable prior URL set for only 5.8% of articles on websites classified as hard news by Bakshy, Messing, and Adamic (2015) (excluding Amazon, Twitter, and YouTube). This pattern of differential Facebook visits immediately prior to fake news website visits is not observed for Google (1.9% fake news versus 6.5% hard news), Twitter (0.9% fake news versus 1.9% hard news), or webmail providers such as Gmail (6.7% fake news versus 7.0% hard news). Our results provide the most compelling independent evidence to date that Facebook was a key vector of fake news distribution (Guess et al., 2018, p. 9).

A survey also indicated that reliance on Facebook increases susceptibility to fake news:

People who said they rely on Facebook as a "major" source of news appeared to be disproportionately susceptible to fake news headlines. In the course of 553 judgments about fake news headlines they recognized, these respondents deemed the information to be somewhat or very accurate 83% of the time.

By comparison, fake news headlines were deemed accurate 76% of the time by people who consider Facebook to be a “minor” source of news (465 judgments), and 64% of the time by people who rarely or never use Facebook for news (498 judgments) (Silverman & Singer-Vine, 2016).

With respect to Prediction 2, there is also some evidence that celebrities and media figures—presumably perceived to be high fitness individuals—play a disproportionately important role in the diffusion process:

the vast majority of shared content does not spread in long cascades among average people. It’s often messages from celebrities and media sources—accounts with high numbers of followers—that increase reach the most, and do so via very shallow diffusion chains (Lazer et al., 2017)

Because ruggedness is better conceived of as a qualitative concept rather than a quantitative metric, there is no direct evidence for Prediction 3. It has been noted, however, that the impact of prior exposure reinforcing beliefs depends upon some level of plausibility:

These results suggest that social media platforms help to incubate belief in blatantly false news stories, and that tagging such stories as disputed is not an effective solution to this problem. Interestingly, however, we also find that prior exposure does not impact entirely implausible statements (e.g., “The Earth is a perfect square”). These observations indicate that although extreme implausibility is a boundary condition of the illusory truth effect, only a small degree of potential plausibility is sufficient for repetition to increase perceived accuracy. As a consequence, the scope and impact of repetition on beliefs is greater than previously assumed (Pennycook et al., 2018).

In domains of substantial ruggedness, our ability to verify information through techniques such as studying internal consistency will be highly degraded owing to the large degree of interaction between attributes. Thus, our ability to judge content as being extremely implausible without conducting subsequent research would tend to be very limited.

PREFERRED INFORMING SOURCES

The preferred informing sources model (Gill, Mullarkey, & Satterfield, 2018) builds on the ruggedness model to consider how our preference for informing sources may change based upon the extrinsic complexity of the environment. Extrinsic complexity extends the concept of ruggedness in several ways:

- Rather than focusing on specific states, it emphasizes sets of states (referred to as statesets) that contain all states meeting specific criteria. For example, desserts would be considered a stateset of the broader set of recipes.
- Fitness is defined more precisely—based on the period-to-period occupancy of a stateset. For example, if 100 people use a given recipe in period 0 and 105 and use the same recipe in period 1, then the period 0 fitness of that recipe would be 1.05 (105/100).
- Because fitness is defined with respect to occupancy, it can be assumed to have a static component that changes very slowly, if at all (e.g., how a given recipe tastes) and a dynamic component, which varies based upon how many occupants it attracts. For some domains—such as the hard sciences—static fitness may dominate (e.g., there is little reason to abandon Newtonian mechanics for those everyday domains where it works). In other domains, such as fashion, the dynamic component may exert almost complete influence on stateset occupancy. For such domains, observing the behavior of others becomes a particularly powerful proxy for fitness.

The model predicts preferred information sources based upon two attributes of the environment: maturity (i.e., How well mapped-out are the peaks and valleys of the environment?) and hostility,

which ranges from hostile (few peaks where agents can remain for long) to bountiful (many peaks exist with fitness near or above 1.0). Because hostile environments tend to promote competition between peers and mature environments do not demand the magnitude of information-seeking behaviors described in the rugged landscape model, the preferred informing sources model predicts that peer-to-peer informing will be most preferred in environments where uncertainty is high (i.e., immature) but where there are also many viable peaks to choose from (i.e., bountiful). In the context of fake news, this would suggest that fake news items would be particularly likely to diffuse under conditions where:

1. Our ability to verify the underlying static fitness of the landscape is low—leading to levels of uncertainty consistent with immature landscapes.
2. A wide range of potential perspectives can co-exist, implying that the landscape is bountiful.
3. Peer-to-peer sharing can occur without the negative consequences of excessive competition.

Many domains explored by the social sciences—such as economics and political science—are built on models that have failed to establish an admirable track in terms of their ability to make long term predictions (Taleb, 2007). For this reason, we might expect peer-to-peer networks based on these groupings to form and, in consequence, be particularly vulnerable to belief in fake news. Networks that are based on sharing of more easily validated information where expertise, rather than self-similarity, is prized—for example, a cooking newsgroup—would likely be less effective in the promulgation of fake news for the purpose of building belief. The differential transmission rates noted earlier (i.e., Guess et al., 2018, p. 9) is consistent with this prediction. Thus, we predict that following:

- Channels known to produce homophilous groupings, such as Facebook and Instagram, would be the preferred channels for building belief in fake news that reinforces the existing beliefs of the channel.

INFORMING TRANSITION

From the client perspective, the decision to become informed can either consist of an incremental step towards increasing fitness—in which case the activity can be viewed as tuning—or as a decision to transition from one peak to another. The informing transition model specifically looks at the process that a client must undergo in moving from one local peak to another. It considers three distinct types of complexity (Gill et al., 2018):

- *Experienced complexity*: Driven largely by unfamiliarity, this form of complexity manifests itself in how we feel as we perform a task (e.g., uncertainty, ambiguity, difficulty).
- *Intrinsic complexity*: The objective level of complexity associated with a particular approach to performing a task (e.g., how much information is required to describe the task, how many logical branches are present, how many concepts does the task involve)
- *Extrinsic complexity*: The relationship between start and end state attributes and fitness, as previously described.

The basic model is presented in Figure 3 (Gill, 2015a, p. 150). Over time, a client existing on a fitness peak will likely experience relatively stable fitness (at or just below 1.0), shown by a line that is roughly horizontal. The assumption is that the client will not move to another peak unless its fitness is expected to be higher.

In order to choose to make the journey, the client must confront all three forms of complexity. First, he or she must conclude that the relative fitness of the end state is greater than that of the current peak. Second, that the intrinsic complexity of the activities involved in the journey warrants the transition through the intermediate low fitness states necessary to reach the target. Finally, the client must somehow minimize or come to accept the experienced complexity (i.e., expected difficulty, uncertainty, ambiguity) associated with the target peak and anticipated transition.

A particularly important aspect of this model is the prediction that individuals will not undertake a significant peak-to-peak transition unless there is relatively compelling evidence that the destination peak is substantially better than the initial peak. This applies no matter how dubious the original beliefs. One example involves a comparison of the prevalence of two arguably false belief sets: belief in alchemy and belief in witchcraft (Gill, 2015b). While the two sets of beliefs were both widespread in the middle ages, modern science and medicine have proven to be far more successful than alchemy in describing the nature of metals and processes for extending life. In consequence, belief in traditional alchemy has subsided dramatically. Science and philosophy have been much less successful in answering questions such as why bad things sometimes happen to good people. In consequence, belief in witchcraft and the supernatural persists at very high levels. For example, in a 2001 survey of U.S. beliefs, more than 40% of the population continued to believe in haunted houses and demonic possession, while more than a quarter believed in astrology and witches (Gill, 2015b, p. 249). A similar unwillingness to reject a poor-performing normal science paradigm in the absence of a verifiably better competing paradigm has been repeatedly observed in the history of science (Kuhn, 1970, p. 77).

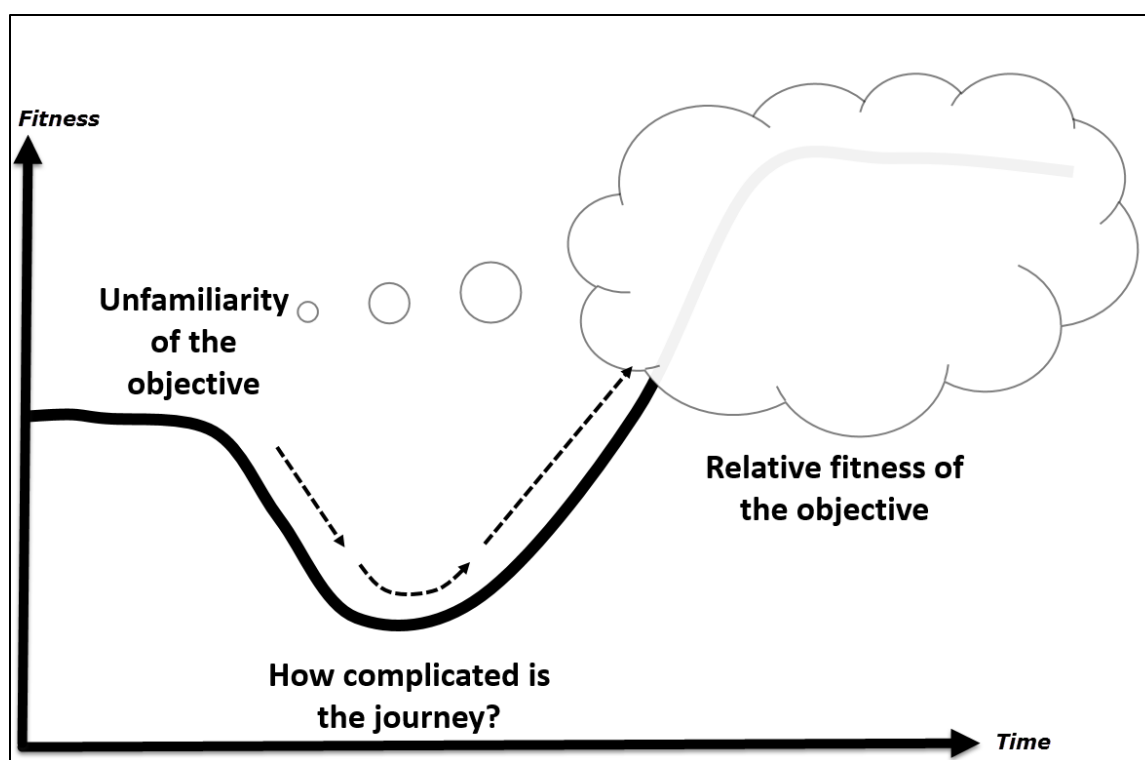


Figure 3. The informing transition model, whereby the client moves from an original knowledge state located at a local fitness peak through a fitness trough (of high cognitive demands and uncertainty) to what is expected to be a knowledge state of higher fitness than the original.

In terms of the implications of this model for fake news, particularly news with ideological content, should the news be consistent with the client's existing ideology, acceptance would represent a tuning activity, and Figure 3 would not apply. This would greatly increase the likelihood of acceptance, particularly when the informer is perceived to be a high fitness peer.

Where the fake news is inconsistent with the client's ideology, incremental acceptance would necessarily result in a fitness decline. Such acceptance would be unusual. Where it did occur, according to this model it would necessarily be in conjunction with a wholesale shift in ideology. While such shifts would be rare, they are expected to occur from time to time in complex environments (Gill, 2015a, p.

112; Taleb, 2007). When they do occur, however, the transitions are likely to be very fast—thereby minimizing the time spent in low-fitness intermediate states—and are also likely to occur as part of a group shift (i.e., the most close-to-vertical portion of the diffusion S-curve).

The analysis presented here leads to a couple of predictions relating to transitions between peaks:

- Individuals will be particularly vulnerable to fake news during periods of rapid ideological shifts.
- Fake news that confirms beliefs associated with the target peak is likely to be more effective in encouraging a transition than fake news that seeks to reduce the credibility of the initial peak.

PREFERRED INFORMING CHANNEL

An informing model based on similar premises specifically focuses on the informer side. As shown in Figure 4 (Gill, 2015b, p. 4), this model can be depicted as a 2 x 2 grid where the diversity of initial client peaks is a continuum on the x-axis, and the number of possible targets (destination peaks) is a continuum on the y-axis.

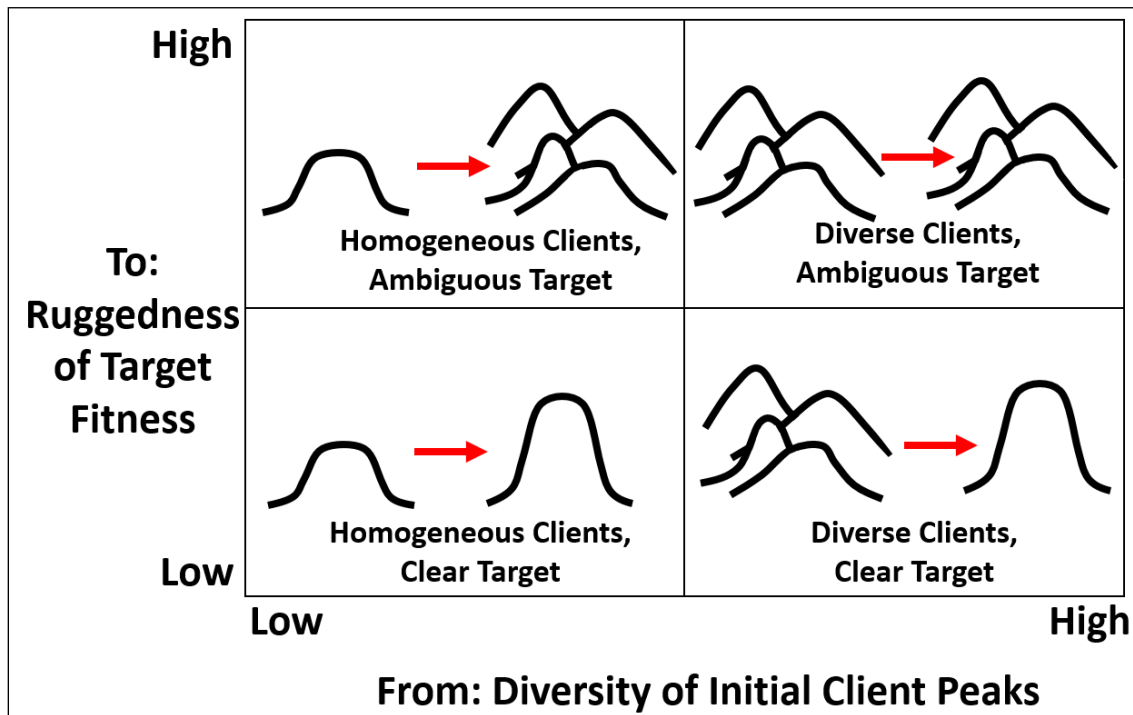


Figure 4. Informer-side channel model of ruggedness vs. client diversity

This model predicts that different informing contexts will benefit from different channels. In the bottom left quadrant, low initial diversity, a clear target, the informer can map out a strategy for minimizing the time spent in the intermediate states between peaks shown in the earlier Figure 3. At the other extreme, the upper right quadrant, the number of different paths required to guide diverse clients to multiple possible targets creates a situation that is essentially impossible for the informer to manage. In the educational context, this quadrant would demand constructivist, peer-to-peer learning techniques wherein each learner chooses an appropriate destination and maps out a strategy for getting there (Gill, 2015a).

From the fake news perspective, broadcasting to disinform a highly diverse set of clients is likely to present problems. First, clients are likely to ignore messages inconsistent with their ideological bent.

Second, should the diverse clients be in communication with each other, substantial negative feedback seems likely to occur and undermine the credibility of a news item before it has a chance for multiple repetitions to increase its perceived validity. Thus, from the disinformers' perspective (i.e., the creator of the fake news) it would make sense to target channels which self-organize in a manner that reduces client diversity. As already noted, social media sites such as Facebook and Instagram frequently enable such ideological homogeneity through friending and liking mechanisms. It has been proposed, however, that the attributes defining self-similarity may vary based upon the nature of the grouping and its objectives (Gill, 2012). Groups based around an activity, such as a bowling league, might not necessarily view self-similarity the same way as groups coming together for political discussions. Thus, we might predict that a Pinterest or Reddit site based on a common interest in cooking would prove to be a poor channel for promoting belief in a specific fake news story—even though it might include some individuals for whom the message was consistent with their ideology.

Figure 4 also opens another intriguing avenue for fake news. The upper left quadrant represents a situation where the informing goal is to move a relatively homogeneous group of clients to a diverse set of target states. Where the objective of the disinformers is to acquire economic benefit from advertising, this quadrant does not make sense. On the other hand, where the disinformers' objective is to sow discord or disrupt existing informing processes, a stream of ambiguous, inconsistent messages that build on the prevailing ideological assumptions but appear to come from different sources could end up fragmenting a community or, at the very least, increase prevailing suspicions regarding news sources in general. To achieve such fragmentation, thereby promoting polarization, it might also make sense for the disinformers to employ channels where ideological homophily was not necessarily going to be present—perhaps even where such messages were likely to be deemed inappropriate. In this context, the objective would *not* be one of promoting belief in the stories. Rather, it would be to further inflame the existing enmity between the subgroups, amplifying the level of polarization. For example:

The new research offers granular detail of efforts by Russian actors, including the Internet Research Agency, a troll farm based in St. Petersburg that is funded by a Kremlin-connected oligarch, to pose as Americans on Facebook, Instagram, YouTube, Twitter, Pinterest and other platforms and inject divisive content into America's political discourse (Volz, 2018).

The Figure 4 model, therefore, suggests two potential scenarios for the disinformers:

- In order to promote interest in a specific fake news item, either for economic purposes or some other reason, homophilous channels where participants are expected to have high receptivity to the message should be selected.
- In order to disrupt informing processes, multiple fake news items from a broad range of perspectives should be inserted into a channel where very diverse degrees of receptivity to each individual item is expected.

The first of these scenarios differs subtly from an earlier proposition in that it focuses on interest in a fake news item, as opposed to achieving belief in an item. From a revenue-generating (i.e., click-bait) perspective, it does not really matter if the client chooses to believe in the item—only that he or she is interested enough to visit the website (and its accompanying advertising). As previously noted, the fake news literature has recognized the similarities between fake news intended as satire vs. fake news meant to deceive (Horne & Adali, 2017; Potthast et al., 2017). Only the latter must achieve client belief in order to succeed in its mission. If the goal of the news is to disrupt, the situation is very different. While the fake news item must appear to be seeking belief—i.e., it is not recognizable as satire or parody—whether client-side belief is ultimately achieved is likely to be irrelevant.

SINGLE CLIENT RESONANCE MODEL

The final informing science model considered in this paper is referred to as the single client resonance model, shown in Figure 5 (Gill, 2105a, p. 268). It is an extension of the bias-filter model (Jamieson & Hyland, 2006) that treats a client as subjecting incoming information to a series of filters prior to absorbing it. The attention filter determines whether a message will simply be ignored. The information filter assesses whether the information is new or can simply be accepted without further processing. The cognitive filter and risk/time preference filter assess whether the incoming information makes sense based upon what we already know and if it is sufficiently certain to be of concern. The motivation filter determines if we care about the information enough to warrant absorbing it and any cognitive dissonance that so doing may produce. Finally, the visceral filter considers the information in terms of its likely emotional impact and is also impacted by the client's motivational state. Structured information in expected format may bypass later filters, but as information becomes less structured and less familiar, it is presumed to require passage through all the filters if it is to be absorbed. The filters can also distort the incoming information in order to reduce the cognitive dissonance associated with absorbing it.

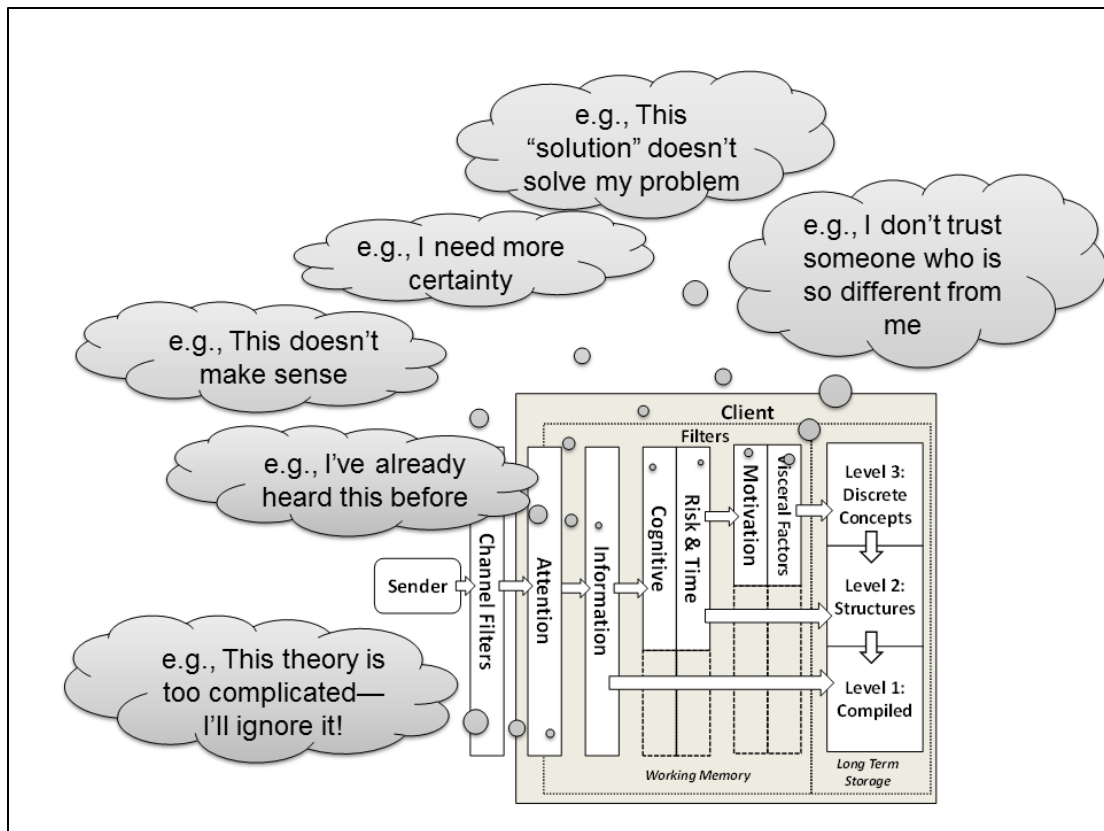


Figure 5. Single client resonance model

Several aspects of fake news appear to be consistent with this model. For example, it has been noted that fake news “appears to feed off of the sensational” (Guo & Vargo, 2018), which would account for its ability to pass through the attention filter. The lower path from the information filter shown in Figure 5 indicates that, under some circumstances, messages may bypass other filters and be absorbed directly—even unconsciously. For example, when we drive down a familiar road under usual traffic conditions, we may not even recall that we have done so. This could, in part, explain the observed phenomenon that repeated exposure to a fake news story increases its perceived validity (Po-

lage, 2012) without our consciously recognizing that fact. The cognitive and risk/time preference filters are the most analytical of the set and are the most likely to look for internal inconsistencies in information. This is consistent with the observation that individuals predisposed towards analysis are more likely to reject fake news (Pennycook & Rand, 2018). With respect to the motivational and visceral filters, the very idea of an “echo chamber” is that it reinforces existing beliefs (Bakir & McStay, 2018), which would serve to motivate acceptance. The same authors assert:

We argue that, at heart, the fake news problem concerns the economics of emotion: specifically, how emotions are leveraged to generate attention and viewing time, which converts to advertising revenue. We further point out the economic and political incentives to produce automated fake news that reacts to what we term online “fellow-feeling”, or group emotional behaviour within social networks ... We suggest that the potential to manipulate public sentiment via empathically optimised automated fake news is a near-horizon problem that could rapidly dwarf the contemporary fake news problem (Bakir & McStay, 2018, p. 155).

It has been previously observed (Gill, 2010) that the single client resonance model can be mapped into the SUCCEs (i.e., simple, unexpected, concrete, credible, emotional, story) framework (Heath & Heath, 2007). Existing research into fake news (e.g., Guo & Vargo, 2018) suggests that fake news is often designed to conform to these specifications. Obviously, it is the “credibility” element that will present the greatest obstacle to the purveyors of fake news. This explains why techniques such as repetition and the use of homophilous channels must be employed. Having said this, it must be recognized that the costs of being disinformed by fake news are relatively low for most clients; few of us are able to exert any direct influence on national issues and, by the same token, the events depicted in fake news story are unlikely to have a direct influence on us. On the other hand, communicating outright rejection of a fake news story could potentially result in exclusion (e.g., we might be “unfriended” on Facebook) from a homophilous group that is otherwise unanimous in its acceptance. The positive motivation to accept such news might, therefore, compensate for some remaining uncertainty relating to the item’s veracity. For example, the gunman who entered a pizza restaurant based on fake news that it was a child trafficking ring run by Hillary Clinton described his intent as “self investigating” (Tandoc et al., 2017), implying that there remained some doubt in his mind. Simply stated:

- In environments of high extrinsic complexity, the importance of truth in a new story will often be secondary to the motivational and emotional benefits that accrue from reinforcing group membership and coherence.

This parallels the psychological utility argument (Alcott & Gentzkow, 2017, p. 218) presented earlier.

DISCUSSION AND DIRECTIONS FOR FUTURE RESEARCH

The analysis of fake news and subsequent examination of various conceptual schemes developed in informing science shows considerable overlap. Before concluding the analysis, it is worth asking a more fundamental question: Can insights from informing science add any value to the study of fake news and its prevention?

Probably the single most important element that flows across all the informing science perspectives is that of complexity, particularly the “real world” form that is referred to as extrinsic complexity. In only 7 of the 52 fake news articles examined was complexity mentioned. In contrast, the present paper uses the term more than 25 times. In the fake news literature, complexity is, at best, taken to be a given in the environment. In the informing science literature, coping with complexity is proposed to be a driving force behind our intake of information. Indeed, studies have proposed that one of the most important reasons that we seek out homophilous groups is that observing how the actions of other members appear to affect their fitness is one of the most efficient ways of gaining insights into how to improve our own fitness (Gill, 2012). This conclusion only holds true for rugged landscape

environments, however. In a simple world, we can gain insights by observing anyone; the positive and negative effects of an action generalize to all agents in such a world.

In a highly complex environment, what constitutes actual “truth” is so large and so complicated as to make it impractical to apply. Thus, searching for conceptual schemes—models or frameworks that are locally useful but are not likely to be generally true—may be more practical than the search for theory (Gill, 2011). Potentially, the same may be said for fake news. If said disinformation has little direct practical consequence for us one way or the other, then either believing it or pretending to believe it (and acting accordingly) would both serve the purpose of reinforcing membership within the group of self-similar individuals who believe (or actively pretend to believe) the same. This raises an interesting question with respect to the consumers of fake news:

- To what degree do the individuals who pass on fake news actively believe its contents?

From an informing science standpoint, this is a very worthy research question for the future. What portion of the phenomenon is real, and what part is simply a practical demonstration of Hans Christian Anderson’s fable “The Emperor’s New Clothes”? The analysis presented also points out that, from the disinformant perspective, achieving belief may not be necessary (from an economic standpoint, achieving interest may suffice) or even desirable (where the goal is to disrupt an informing channel). This raises another question worthy of future investigation:

- Is a disinformant’s objective in communicating fake news reflected in the disinformant’s choice of informing channel?

Also, from an informing standpoint, it seems unlikely that fake news items will generally be able to precipitate significant transitions in ideology and behavior. Incremental changes that do not change the underlying peak sought by the client (i.e., tuning), such as deciding whether to vote in an election, may be affected. Under those rare conditions where fake news does precipitate, or at least accompany, a significant change in the client, the models predict it will occur only where:

1. The perceived fitness of the client’s initial state is low.
2. A more attractive state, consistent with the news item(s), is clearly defined.
3. Evidence that other clients are transitioning is observed.

Diffusion models (e.g., Rogers, 2003) may help us better understand that process. If we were to characterize fake news items as being regular (i.e., targeting incremental belief associated with tuning to a peak) or transitional (i.e., targeting a significant shift in beliefs, as represented by transitioning to another peak), we might investigate twin questions:

- Does the acceptance of regular fake news follow a conventional diffusion curve?
- Does the acceptance of transitional fake news follow a conventional diffusion curve?

Based on the arguments we have presented, we might predict the answer to the second question to be “yes”, with its associated make-up of early adopters, regular adopters and laggards. For the first question, the predicted answer would be far less obvious. Information cascade models, such as those mimicking disease transmission (Kucharski, 2016; Roozenbeek & van der Linden, 2018) might prove to be a better fit.

Taken together, the questions posed here offer an intriguing research agenda in the area of fake news; an important but still emerging area in which rigorous contributions can still exert a significant influence on the field.

CONCLUSIONS

As noted in the introduction, the goal of the present paper has not been to present new research into fake news. Rather, it has been to show the potential relevance of existing informing science conceptual schemes to the fake news topic. Significant overlap between five of these informing science frameworks and the emerging literature on fake news has been demonstrated. While not within the scope of this paper, there are also a variety of other conceptual schemes with obvious relevance to fake news—such as the diffusion of information, self-organizing networks and material related to the risks of misinforming—that have been developed outside of informing science but which have been applied in the transdiscipline (e.g., Gill, 2015a, p. 358; Gill, 2015b, pp. 105 & 159).

Within the current paper, a variety of conceptual schemes from informing science—particularly those dealing with the impact of different types of complexity on how we inform and are informed—have been explored with respect to their potential contribution to our understanding of fake news. Among the questions of interest that have been identified:

- Does fake news need to disinform its clients if it is to be effective?
- Why are certain groups of individuals particularly credible when it comes to communicating fake news?
- Under what circumstances will the emotional and social motivations to accept fake news exceed our concern for its truth?
- How does the nature of the fake news content and objectives impact the disinformers' choice of channel?
- What are the circumstances under which radically transitional fake news might have an impact?

If informing science researchers investigate questions such as these, the answers they find can make a significant contribution to our understanding of fake news. There would be a complementary impact as well. Informing science has long been interested in understanding the processes involved in misinforming and disinforming. The study of fake news, both within informing science and outside of the transdiscipline, provides a marvelous laboratory for investigating the flow of ideas, particularly false ideas, whose spread is enabled by technology. By incorporating fake news research into the informing science framework, we gain the opportunity to test and refine our broader understanding of the dark side of informing.

REFERENCES

- Alcott, H., & Gentzkow, M. (2017). Social media and fake news in the 2016 election. *Journal of Economic Perspectives* 31(2), 211-236. <https://doi.org/10.1257/jep.31.2.211>
- Bakir, V., & McStay, A. (2018). Fake news and the economy of emotions, *Digital Journalism*, 6(2), 154-175. <https://doi.org/10.1080/21670811.2017.1345645>
- Bakshy, E., Messing, S., & Adamic, L. A. (2015). Exposure to ideologically diverse news and opinion on Facebook. *Science*, 348(6239), 1130-1132. <https://doi.org/10.1126/science.aaa1160>
- Balmas, M. (2014). When fake news becomes real: Combined exposure to multiple news sources and political attitudes of inefficacy, alienation, and cynicism. *Communication Research*, 41(3), 430-454. <https://doi.org/10.1177/0093650212453600>
- Berghel, H. (2017). Lies, damn lies, and fake news. *Computer*, 2, 80-85. <https://doi.org/10.1109/MC.2017.56>
- Berkowitz, D., & Schwartz, D. A. (2016). Miley, CNN and The Onion: When fake news becomes realer than real. *Journalism Practice*, 10(1), 1-17. <https://doi.org/10.1080/17512786.2015.1006933>
- Blake, A. (2018, April 3). A new study suggests fake news might have won Donald Trump the 2016 election. *Washington Post*. Retrieved from <https://www.washingtonpost.com/news/the-fix/wp/2018/04/03/a-new-study-suggests-fake-news-might-have-won-donald-trump-the-2016-election/>

- Borden, S. L., & Tew, C. (2007). The role of journalist and the performance of journalism: Ethical lessons from “fake” news (seriously). *Journal of Mass Media Ethics*, 22(4), 300-314. <https://doi.org/10.1080/08900520701583586>
- Brewer, P. R., Young, D. G., & Morreale, M. (2013). The impact of real news about “Fake News”: Intertextual processes and political satire. *International Journal of Public Opinion Research* 25(3), 323-343. <https://doi.org/10.1093/ijpor/edt015>
- Carlson, M. (2018). Fake news as an informational moral panic: The symbolic deviancy of social media during the 2016 US presidential election. *Information, Communication & Society*. 1-15. <https://doi.org/10.1080/1369118X.2018.1505934>
- Chen, Y., Conroy, N. J., & Rubin, V. L. (2015, November). Misleading online content: Recognizing clickbait as false news. *Proceedings of the 2015 ACM on Workshop on Multimodal Deception Detection* (pp. 15-19). ACM. <https://doi.org/10.1145/2823465.2823467>
- Cohen, E. B. (1999). Reconceptualizing information systems as a field of the discipline informing science: From ugly duckling to swan, *Journal of Computing and Information Technology*, 7(3), 213-219.
- Cohen, E.B. (2009). A philosophy of informing science, *Informing Science: The International Journal of an Emerging Transdiscipline*, 12, 1-15. <https://doi.org/10.28945/425>
- Conroy, N. J., Rubin, V. L., & Chen, Y. (2015, November). Automatic deception detection: Methods for finding fake news. *Proceedings of the 78th ASIS&T Annual Meeting: Information Science with Impact: Research in and for the Community* (p. 82). American Society for Information Science.
- Costera Meijer, I. (2007). The paradox of popularity: How young people experience the news. *Journalism Studies*, 8(1), 96-116. <https://doi.org/10.1080/14616700601056874>
- Domonoske, C. (2016). Students have “dismaying” inability to tell fake news from real, study finds. *National Public Radio*, 23.
- Farkas, J., & Schou, J. (2018). Fake news as a floating signifier: Hegemony, antagonism and the politics of falsehood, *Javnost - The Public*, 25(3), 298-314.
- Fletcher, R., Cornia, A., Graves, L., & Nielsen, R. K. (2018). Measuring the reach of “fake news” and online disinformation in Europe. *Reuters Institute Factsheet*. Retrieved from <https://reutersinstitute.politics.ox.ac.uk/our-research/measuring-reach-fake-news-and-online-disinformation-europe>
- Gandolfi, A. E., Gandolfi, A. S., & Barash, D. (2002). *Economics as an evolutionary science: From utility to fitness*. New Brunswick, NJ: Transaction Publishers.
- Gill, T. G. (2010). *Informing business: Research and education on a rugged landscape*. Santa Rosa, CA: Informing Science Press.
- Gill, T. G. (2011). When what is useful is not necessarily true: The underappreciated conceptual scheme. *Informing Science*, 14, 1-32. <https://doi.org/10.28945/1348>
- Gill, T. G. (2012). Informing on a rugged landscape: Homophily versus expertise. *Informing Science: The International Journal of an Emerging Transdiscipline*, 15, 49-91. <https://doi.org/10.28945/1560>
- Gill, T. G. (2015a). *Informing science, volume one: Concepts and systems*, Santa Rosa, CA: Informing Science Press.
- Gill, T. G. (2015b). *Informing science, volume two: Design and research issues*, Santa Rosa, CA: Informing Science Press.
- Gill, T. G., Mullarkey, M., & Satterfield, R. K. (2018). Informing on a rugged landscape: How complexity drives our preferred information sources. *Informing Science: The International Journal of an Emerging Transdiscipline*, 21, 1-18. <https://doi.org/10.28945/3977>
- Guess, A., Nyhan, B., & Reifler, J. (2018). Selective exposure to misinformation: Evidence from the consumption of fake news during the 2016 US presidential campaign. *European Research Council*, 9.
- Guo, L., & Vargo, C. (2018). “Fake News” and emerging online media ecosystem: An integrated intermedia agenda-setting analysis of the 2016 US presidential election. *Communication Research*, 1-23. <https://doi.org/10.1177/0093650218777177>

- Habgood-Coote, J. (2018). Stop talking about fake news! *Inquiry*, 1-33. <https://doi.org/10.1080/0020174X.2018.1508363>
- Haigh, M., Haigh, T., & Kozak, N. I. (2018). Stopping fake news: The work practices of peer-to-peer counter propaganda. *Journalism Studies*, 19(14), 2062-2087. <https://doi.org/10.1080/1461670X.2017.1316681>
- Heath, C., & Heath, D. (2007). *Made to stick: Why some ideas survive and others die*. New York, NY: Random House.
- Horne, B. D., & Adali, S. (2017). This just in: Fake news packs a lot in title, uses simpler, repetitive content in text body, more similar to satire than real news. *CoRR*, *abs/1703.09398*.
- Jamieson, K., & Hyland, P. (2006). Good intuition or fear and uncertainty: The effects of bias on information systems selection decisions. *Informing Science: The International Journal of an Emerging Transdiscipline*, 9, 49-69. <https://doi.org/10.28945/471>
- Kang, C. (2016, November 21). Fake news onslaught targets pizzeria as nest of child-trafficking. *The New York Times*. Retrieved from <http://nyti.ms/2f0L9G9>
- Kauffman, S. A. (1993). *The origins of order*. Oxford, UK: Oxford University Press.
- Khaldarova, I., & Pantti, M. (2016). Fake news: The narrative battle over the Ukrainian conflict. *Journalism Practice*, 10(7), 891-901. <https://doi.org/10.1080/17512786.2016.1163237>
- Kucharski, A. (2016). Post-truth: Study epidemiology of fake news. *Nature*, 540(7634), 525. <https://doi.org/10.1038/540525a>
- Kuhn, T. S. (1970). *The structure of scientific revolution, second edition, enlarged*. Chicago, IL: University of Chicago Press.
- Lazer, D., Baum, M., Grinberg, N., Friedland, L., Joseph, K., Hobbs, W., & Mattsson, C. (2017). Combating fake news: An agenda for research and action. *Harvard Kennedy School, Shorenstein Center on Media, Politics and Public Policy*, 2. Retrieved from <https://shorensteincenter.org/combating-fake-news-agenda-for-research/>
- Lazer, D. M., Baum, M. A., Benkler, Y., Berinsky, A. J., Greenhill, K. M., Menczer, F., ... & Schudson, M. (2018). The science of fake news. *Science*, 359(6380), 1094-1096. <https://doi.org/10.1126/science.aao2998>
- Lischka, J. A. (2017). A badge of honor? How *The New York Times* discredits President Trump's fake news accusations. *Journalism Studies*, 1-18.
- Marchi, R. (2012). With Facebook, blogs, and fake news, teens reject journalistic "objectivity". *Journal of Communication Inquiry*, 36(3), 246-262. <https://doi.org/10.1177/0196859912458700>
- Mihailidis, P., & Viotty, S. (2017). Spreadable spectacle in digital culture: Civic expression, fake news, and the role of media literacies in "post-fact" society. *American Behavioral Scientist*, 61(4), 441-454. <https://doi.org/10.1177/0002764217701217>
- Mustafaraj, E., & Metaxas, P. T. (2017, June). The fake news spreading plague: Was it preventable? *Proceedings of the 2017 ACM on Web Science Conference* (pp. 235-239). ACM. <https://doi.org/10.1145/3091478.3091523>
- Newman, N., Fletcher, R., Kalogeropoulos, A., Levy, D. A., & Nielsen, R. K. (2017). *Reuters Institute digital news report 2017*. Retrieved from <http://www.digitalnewsreport.org/survey/2017/>
- Pennycook, G., & Rand, D. G. (2018, May 23). Who falls for fake news? The roles of bullshit receptivity, overclaiming, familiarity, and analytic thinking. <http://dx.doi.org/10.2139/ssrn.3023545>
- Pennycook, G., & Rand, D. G. (2019, March 15). The implied truth effect: Attaching warnings to a subset of fake news stories increases perceived accuracy of stories without warnings. Retrieved from <https://osf.io/b5m3n>
- Pennycook, G., Cannon, T. D., & Rand, D. G. (2018). Prior exposure increases perceived accuracy of fake news. *Journal of Experimental Psychology: General*, 147(12), 1865-1880. <https://doi.org/10.1037/xge0000465>
- Peters, M. A. (2018). Education in a post-truth world. *Post-truth, fake news* (pp. 145-150). Singapore: Springer. https://doi.org/10.1007/978-981-10-8013-5_12
- Polage, D. C. (2012). Making up history: False memories of fake news stories. *Europe's Journal of Psychology*, 8(2), 245-250. <https://doi.org/10.5964/ejop.v8i2.456>

- Potthast, M., Kiesel, J., Reinartz, K., Bevendorff, J., & Stein, B. (2017). A stylometric inquiry into hyperpartisan and fake news. *CoRR*. Retrieved from <http://arxiv.org/abs/1702.05638>
- Rashkin, H., Choi, E., Jang, J. Y., Volkova, S., & Choi, Y. (2017). Truth of varying shades: Analyzing language in fake news and political fact-checking. *Proceedings of the 2017 Conference on Empirical Methods in Natural Language Processing* (pp. 2931-2937). <https://doi.org/10.18653/v1/D17-1317>
- Reilly, I. (2012). Satirical fake news and/as American political discourse. *The Journal of American Culture*, 35(3), 258-275. <https://doi.org/10.1111/j.1542-734X.2012.00812.x>
- Rogers, E. M. (2003). *Diffusion of innovations* (4th ed.). New York, NY: Free Press.
- Roozenbeek, J., & van der Linden, S. (2018). The fake news game: actively inoculating against the risk of misinformation. *Journal of Risk Research*, 1-11. <https://doi.org/10.1080/13669877.2018.1443491>
- Rubin, V. L., Chen, Y., & Conroy, N. J. (2015, November). Deception detection for news: Three types of fakes. *Proceedings of the 78th ASIS&T Annual Meeting: Information Science with Impact: Research in and for the Community* (p. 83). American Society for Information Science. <https://doi.org/10.1002/pra2.2015.145052010083>
- Rubin, V. L., Conroy, N., Chen, Y., & Cornwell, S. (2016). Fake news or truth? Using satirical cues to detect potentially misleading news. *Proceedings of the Second Workshop on Computational Approaches to Deception Detection* (pp. 7-17). Association for Computational Linguistics. <https://doi.org/10.18653/v1/W16-0802>
- Shao, C., Ciampaglia, G. L., Varol, O., Flammini, A., & Menczer, F. (2017). The spread of fake news by social bots. *CoRR. arXiv preprint arXiv:1707.07592*, 96-104.
- Shu, K., Sliva, A., Wang, S., Tang, J., & Liu, H. (2017). Fake news detection on social media: A data mining perspective. *ACM SIGKDD Explorations Newsletter*, 19(1), 22-36. <https://doi.org/10.1145/3137597.3137600>
- Silverman, C. (2016, December 30). Here are 50 of the biggest fake news hits on Facebook from 2016. *BuzzFeed*. Retrieved from <https://www.buzzfeednews.com/article/craigsilverman/top-fake-news-of-2016>
- Silverman, C., & Singer-Vine, J. (2016a, December 6). Most Americans who see fake news believe it, new survey says. *BuzzFeed News*. Retrieved from <https://www.buzzfeednews.com/article/craigsilverman/fake-news-survey>
- Spinny, L. (2017). The shared past that wasn't. *Nature*, 543, 168-170.
- Sydell, L. (2016, November 23). We tracked down a fake-news creator in the suburbs. Here's what we learned. *National Public Radio*, <https://www.npr.org/sections/alltechconsidered/2016/11/23/503146770/npr-finds-the-head-of-a-covert-fake-news-operation-in-the-suburbs>
- Tacchini, E., Ballarin, G., Della Vedova, M. L., Moret, S., & de Alfaro, L. (2017). Some like it hoax: Automated fake news detection in social networks. Retrieved from <https://arxiv.org/abs/1704.07506>
- Taleb, N. N. (2007). *The black swan: The impact of the highly improbable*. New York, NY: Random House.
- Tandoc, Jr, E. C., Lim, Z. W., & Ling, R. (2018). Defining "fake news": A typology of scholarly definitions. *Digital Journalism*, 6(2), 137-153. <https://doi.org/10.1080/21670811.2017.1360143>
- Vargo, C. J., Guo, L., & Amazeen, M. A. (2018). The agenda-setting power of fake news: A big data analysis of the online media landscape from 2014 to 2016. *New Media & Society*, 20(5), 2028-2049. <https://doi.org/10.1177/1461444817712086>
- Volz, D. (2018, December 17). Russians took aim at black voters to boost Trump, reports to senate find. *Wall Street Journal*. Retrieved from <https://www.wsj.com/articles/russians-took-aim-at-black-voters-to-boost-trump-reports-to-senate-find-11545066563>
- Wardle, C. (2017, February 16). Fake news. It's complicated. *First Draft News*. Retrieved from <https://firstdraft-news.org/fake-news-complicated/>

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