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Using Psychological Science to Understand and Fight Health Misinformation

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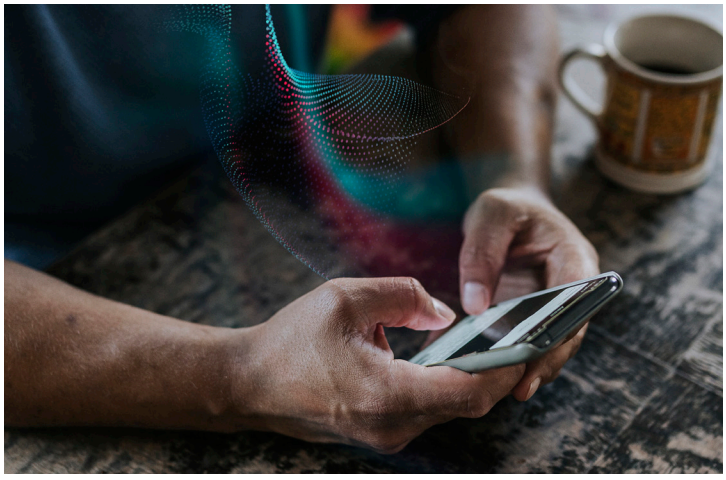

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ABSTRACT

There is widespread concern that misinformation poses dangerous risks to health, well-being, and civic life. Despite a growing body of research on the topic, significant questions remain about (a) psychological factors that render people susceptible to misinformation, (b) the extent to which it affects real-world behavior, (c) how it spreads online and offline, and (d) intervention strategies that counter and correct it effectively. This report reviews the best available psychological science research to reach consensus on each of these crucial questions, particularly as they pertain to health-related misinformation. In addition, the report offers eight specific recommendations for scientists, policymakers, and health professionals who seek to recognize and respond to misinformation in health care and beyond.

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THE CONSENSUS PROCESS

Contributing authors were selected by APA and CDC staff based on peer recommendations and subject-matter expertise in domains related to misinformation science. Each section of the report was drafted by two authors with input from the lead editor. The resulting draft document was then reviewed by all contributing authors, and additional research and viewpoints were considered for inclusion. The lead editor guided discussion and mediated differences in viewpoint until unanimous agreement was reached on all content and recommendations. APA and CDC staff offered anonymous reviews of the final report, and APA staff provided editorial and production services. All authors were compensated for their time and scholarship.

Introduction

In 2020, the World Health Organization (WHO) declared a worldwide "infodemic" (Briand et al., 2021; Tedros, 2020) based on concerns that "a global epidemic of misinformation—spreading rapidly through social media platforms and other outlets—poses a serious problem for public health" (Zarocostas, 2020, p. 1). Misinformation certainly appears to present a growing and pernicious threat to public well-being, but to what extent does research support claims about its spread and impact? The emerging evidence is complex. For example, studies have indeed found that unreliable information can spread rapidly on social media (Vosoughi et al., 2018), especially during a pandemic (Gallotti et al., 2020)—but other studies have found that purely "false or misleading information masquerading as legitimate news" constitutes only a fraction of people's overall media consumption (Allen et al., 2020).

There are many open questions about the harmful consequences of misinformation on health and well-being. Although the mainstream media often reports that individuals have refused life-saving hospital treatment for COVID-19 because of conspiracy theories (Brummel, 2022), it is important to note that these findings do not characterize the general population. Exposure to foreign disinformation campaigns predicts lower vaccine uptake around the world (Wilson & Wiysonge, 2020). However, there is a notable lack of direct experimental evidence linking exposure to misinformation with observable changes in behavior, and longitudinal associations tend to be small. Emerging reports about the public health and economic impacts of vaccine hesitancy are striking (Council of Canadian Academies [CCA], 2023; Simmons-Duffin & Nakajima, 2022), yet vaccination decisions are complex and shaped by many factors. Nonetheless, some models suggest that without intervention, anti-vaccination narratives will dominate Facebook within the next decade (N. F. Johnson et al., 2020). Other potential consequences of misinformation include violence and destruction of property, such as the cellular phone towers that people set ablaze following news coverage of conspiracy theories about the dangers of 5G wireless technology (Jolley & Paterson, 2020).

Of course, the spread of health misinformation is nothing new. Immunization has been a reliable target for misinformation since the world's first vaccine—for smallpox—was delivered in 1796 (WHO, n.d.). In more recent history, misinformation about the MMR vaccine, amplified by the mainstream media in the 1990s, has been associated with significant decreases in vaccine uptake (Burgess et al., 2006; Lewis & Speers, 2003; Motta & Stecula, 2021), and alternative medicine treatments for cancer, often rooted in pseudoscience and misinformation, predict substantially higher risk of death (S. B. Johnson et al., 2018). Yet, while there is consensus that misinformation plays a role in many of these examples, scholars have noted the lack of direct causal evidence (e.g., Altay, Berriche, & Acerbi, 2023).

Broadly speaking, misinformation can promote discord by increasing political polarization (Van Bavel et al., 2021) and eroding trust in democracy, the media, and public health authorities (Calleja et al., 2021; Jones-Jang et al., 2021; Ognyanova et al., 2020). To fully grasp the impact of health misinformation in our time, it is necessary to understand the psychological factors that drive it in general: the qualities that make us likely to believe and share it, the levers of manipulation used by its creators, and the network effects induced by today's media and political landscape. Using these insights, psychological scientists have developed and tested a broad array of methods to address and counter misinformation, many of which are examined in this report.

STATEMENT OF PURPOSE

Research on the psychology of misinformation has proliferated in recent years (e.g., Ecker et al., 2022; Roozenbeek et al., 2023; Swire-Thompson & Lazer, 2019; Van Bavel et al., 2021; van der Linden, 2022, 2023). Nevertheless, experts remain sharply divided on many key issues, including how to define misinformation clearly, how to quantify how many people are regularly exposed to it, what factors make people susceptible to believing and sharing it online and offline, and how best to counter the problem at scale.

For example, some researchers suggest that misinformation makes up a tiny fraction (~1%) of people's overall news consumption (Allen et al., 2020), but others find that it occurs more frequently in specific content areas: Visually misleading information comprises up to 20% of political media content (Yang et al., 2023), and health misinformation is highly prevalent in social media feeds (Wang et al., 2019). Some scholars find that misinformation on social media spreads faster and deeper than accurate information (Vosoughi et al., 2018), while others do not (Cinelli et al., 2020). Some claim that people fall for misinformation primarily because they are not paying attention to accuracy (Pennycook & Rand, 2019), but others find that people spread misinformation because it aligns with their social and political identities (Osmundsen et al., 2021; Van Bavel et al., 2021). Although some scholars find that fact-checking can sometimes backfire (Autry & Duarte, 2021; Krause et al., 2022; Nyhan & Reifler, 2015), others urge that health authorities can debunk misinformation without worrying about backfire effects because they show poor replicability (Prike et al., 2023; Swire-Thompson et al., 2020; Wood & Porter, 2019). Finally, some maintain that the relationship between misinformation and real-world health behavior is fairly weak (Altay, Berriche, & Acerbi, 2023; Crocco et al., 2002), while others find that it can lead to significant real-world harm (e.g., CCA, 2023; S. B. Johnson et al., 2018; Wilson & Wiysonge, 2020).

Perhaps unsurprisingly, like many aspects that govern human behavior, the issue is complex, nuanced, and multidimensional, and not all methods are created equal. For example, when it comes to prevalence, belief in some conspiracy theories has increased over time (e.g., the claim that "Big Pharma" invents new diseases to increase sales), and belief in others has decreased (e.g., allegations that the school shooting in Sandy Hook, Connecticut, was a hoax; Uscinski et al., 2022). Population-level estimates suggest that health misinformation can make up between 0.2% to 29% of people's overall news intake (Altay, Nielsen, & Fletcher, 2022; Borges do Nascimento et al., 2022). Yet, these estimates are often platform-specific, constrained to textual information, based on limited public data, and insensitive to the fact that some racial or political groups might be disproportionately targeted (Freelon et al., 2022; Freelon & Lokot, 2020; Yang et al., 2023). Moreover, analyses of real-world consequences are often impeded by measurement issues and difficulties in isolating the causal forces that drive people's decisions (Altay, Berriche, & Acerbi, 2023).

These conflicting accounts can lead to confusion in the literature as well as among policymakers and practitioners, delaying or undermining appropriate action. The purpose of this report is to bring clarity to these important debates by providing a consensus view on three critical overarching questions about misinformation research, particularly as it relates to health:

1. What are the psychological factors that make people susceptible to believe and act on misinformation?
2. How and why does misinformation spread?
3. What interventions can be used to counter misinformation effectively?

Although not itself a systematic review, our report is based on peer-reviewed empirical studies and includes primary research articles, meta-analyses, systematic reviews, case studies, and other reports. We conclude with eight specific recommendations for scientists, policymakers, and health professionals.

DEFINING MISINFORMATION

The answers to the preceding questions depend on how we define misinformation in the first place. For example, although "false or misleading information masquerading as legitimate news" is not very common, unintentionally misleading content is much more prevalent. The challenge of defining the concept of misinformation has attracted a wide range of perspectives (e.g., Freelon & Wells, 2020; Roozenbeek et al., 2023; Southwell et al., 2022; Tandoc et al., 2018; Vraga & Bode, 2020). Despite disagreement on how to best measure, define, and operationalize misinformation (van der Linden, 2022), there is increasing consensus that the term "fake news" is best avoided as an umbrella term due to its lack of specificity and the fact that it has become a highly politicized term (Habgood-Coote, 2019; van der Linden, Panagopoulos, & Roozenbeek, 2020; Wardle, 2018).

One approach to defining misinformation has been to operationalize it at the level of the credibility of the source, with "accuracy determined more by the source of an article or claim than by its content (e.g., Altay, Nielsen, & Fletcher, 2022; Grinberg et al., 2019). The underlying idea here is that low-credibility media outlets are likely to share more misinformation than high-credibility ones. Others have defined misinformation in terms of whether content has been fact-checked (Pennycook & Rand, 2019) or whether claims run contrary to prevailing expert consensus (Vraga & Bode, 2020). Although the term is loaded, some scholars have specifically defined "fake news" as "fabricated information that mimics news media content in form but not in organizational process or intent" (Lazer et al., 2018, p. 1094). None of these definitions are perfect, and they should be viewed as complementary rather than competing, as each approach has its own strengths and weaknesses: Source-based definitions suffer because they miss false claims from credible and more influential mainstream outlets (Traberg, 2022); the best available evidence is not always clear and may be subject to revision (Krause et al., 2022; Swire-Thompson & Lazer, 2019); and most problematic information is not completely false but rather manipulative, biased, or otherwise misleading (Wardle, 2018).

Our definition, therefore, focuses on the extent to which a headline or claim shows evidence of manipulation, regardless of the article's source, its intent, or whether it has been fact-checked. A good example is the headline: "A 'healthy' doctor died two weeks after getting a COVID-19 vaccine; CDC is investigating why" (Benton, 2021). This article was published by a credible outlet—the *Chicago Tribune*—and, technically, it is not false: A healthy doctor did, in fact, die 2 weeks after receiving the vaccine. However, there was no evidence at the time that the doctor died *because* of the COVID-19 vaccine, yet the headline used a framing technique that raised concern (van der Linden, 2022). In fact, the article became the most shared story on Facebook in the first quarter of 2021, especially among anti-vaccination groups (Benton, 2021).

Another distinction is often made between *misinformation* and *disinformation*, in which the latter involves explicit intent to manipulate or deceive others (van der Linden & Roozenbeek, 2020; Wardle, 2018). Motive is useful to consider, but it is often hard to prove without legal or historical documentation (Swire-Thompson & Lazer, 2019). Accordingly, we adopt the broader term *misinformation* in this report unless we refer to documented disinformation campaigns where intent has been established legally or otherwise. We define misinformation in the broadest possible sense as *any information that is demonstrably false or otherwise misleading, regardless of its source or intention*. Verification may be determined by fact-checking, benchmarking against expert or scientific consensus, or identifying known characteristics of deceptive or epistemologically dubious content (e.g., lack of context, logical fallacies, manipulation, opinions presented as facts).

Susceptibility: Why Do People Believe Misinformation?

Our brains are amazing computational machines. In a tenth of a second, we can view a complex scene and determine whether the setting is man-made or natural (M. R. Greene & Oliva, 2009) or whether a face is fearful or neutral (Eimer & Holmes, 2002). Yet, it is much more difficult to determine if information is true or false. We rarely focus our early attention on the accuracy of what we read or hear; instead, we focus on comprehending it and deciding what to say or do next (Barsalou, 1999; Ferreira et al., 2002; Ferreira & Patson, 2007). For example, when asked "How many animals of each kind did *Moses* take on the Ark?" most people responded "two," even when follow-up questions showed that they knew that *Noah*, not Moses, built the Ark in the biblical story (Erickson & Mattson, 1981; see also Bottoms et al., 2010). In another example, nearly 50% of Duke University biology graduate students failed to notice the error in the question "During what trimester can a single embryo split to form *fraternal* twins?" despite knowing that *identical* twins are formed when an embryo splits (Cantor & Marsh, 2017). When asked, participants were able to repeat these questions accurately (Erickson & Mattson, 1981), suggesting that they processed the false information but failed to notice its contradiction with their prior knowledge.

In short, people often have relevant information stored in memory, but they fail to retrieve and use it under new, incorrect conditions. Researchers call this phenomenon "knowledge neglect" (Marsh & Umanath, 2013). Not only are people bad at noticing when existing knowledge conflicts with new information, but they may also learn the incorrect information and use it in new situations. For example, people who answered the question about Noah's Ark were more likely to answer the follow-up question "Who built and sailed the Ark?" with "Moses" (Bottoms et al., 2010), and readers of a fictional story that mentioned "St. Petersburg, the capital of Russia" were more likely to answer the question "What's the capital of Russia?" with "*St. Petersburg*," even if they had correctly answered "*Moscow*" 2 weeks earlier (L. K. Fazio et al., 2013).

However, there are factors that mitigate knowledge neglect. Greater insight about the plausibility of a particular claim helps people recognize errors in what they are reading: Participants easily noticed that the question "How many animals did *Nixon* take on the Ark?" is incorrect (Erickson & Mattson, 1981), and they tended not to learn implausible information in fictional stories such as "*Pluto* is the largest planet" (Hinze et al., 2014). Greater subject knowledge also helps: Biology graduate students were more likely than history graduate students to notice the error in the question about fraternal twins (Cantor & Marsh, 2017).

These psychological science findings help to explain how misinformation enters our thought processes. Research on knowledge neglect suggests that it is effortful and difficult for our brains to apply existing knowledge when encountering new information; when new claims are false but sufficiently reasonable, we can learn them as facts. Thus, everyone is susceptible to misinformation to some degree: We acquire it even when we know better, because fact-checking for accuracy is such a difficult cognitive task. These challenges persist whether we are parsing the biblical flood or Russian geography, viewing posts about vaccines on our social media feed, hearing about the newest immune system booster from a relative, or watching a television host talk about a new dietary supplement. In this view, health misinformation is simply a specific type of misinformation that follows similar rules.

FACTORS THAT INFLUENCE SUSCEPTIBILITY TO MISINFORMATION

While it may be difficult to notice false information in real time, this susceptibility to misinformation rises and falls depending on specific characteristics of the information and its viewer.

Information from in-group sources is generally more believable than information from out-group sources, and the same is true for misinformation. One strong affinity in this regard is political alignment: Misinformation from conservative sources was rated as more accurate by conservative participants than by liberal ones, while misinformation from liberal sources was rated as more accurate by liberal participants than by conservative ones (Traberg & van der Linden, 2022). One reason that in-group sources are viewed as more accurate is that they are viewed as more trustworthy: Research on persuasion shows that people often rely on beliefs about a source's credibility when judging the accuracy of its reporting (e.g., Pornpitakpan, 2004), regardless of whether it is true or false (Nadarevic et al., 2020) and especially when information is new (Kumkale & Albarracín, 2004). Consistent with this view, the source

effects described previously were mediated by ratings that the information was credible (Traberg & van der Linden, 2022). In other words, liberals judged misinformation from conservative sources to be inaccurate specifically because they did not trust the source (and vice versa for conservatives). Effects like these may explain why trust in scientists has been linked to lower belief in COVID-19 misinformation (Roozenbeek et al., 2020).

Another finding sheds further light on the impact of misinformation presented by credible or trustworthy communicators. Researchers developed social media "influencer" profiles and presented patterns of health-related misinformation to study participants over time. Later, they asked participants questions about their health beliefs (e.g., "A healthy lifestyle . . . can completely prevent someone from being infected with COVID-19"), health attitudes (e.g., "I do not think that COVID-19 is a dangerous disease"), and trust in sources of official health information (e.g., "The media in general tries to hide information about COVID-19 from the public"). Although repeated misinformation had no effect on these outcomes by itself, it did lead to lower trust in official health sources in cases where participants found the influencer highly trustworthy (Harff et al., 2022).

The content of misinformation also affects belief. Americans were more likely to believe inaccurate news stories criticizing their opposing political party than those criticizing their preferred party (Pereira et al., 2021). Similarly, people in Ireland falsely remembered fake scandals more often when the scandal reflected negatively on out-group members (Murphy et al., 2019). The emotional impact of content matters as well: People were more likely to believe false statements that would make a believer happy (e.g., "Positive thoughts can cleanse the body of toxins") compared with statements that would make one sad (e.g., "Bad things happen to certain people because they attract negative energy"; Altay, Majima, & Mercier, 2023). There is both correlational and causal evidence that inducing an emotional state can also make people more susceptible to misinformation (Martel et al., 2020).

We also know that repetition can play a role in shaping people's beliefs. Repeated information is thought to be more true, even when it contradicts our prior knowledge (e.g., L. K. Fazio et al., 2015); this phenomenon is known as "illusory truth" (see Dechêne et al., 2010, for a meta-analysis). For example, people who read "The *Minotaur* is the legendary one-eyed giant in Greek mythology" twice were more likely to think that it is true than people who read it only once, even if 2 weeks earlier they correctly identified the one-eyed giant as a *Cyclops* (L. K. Fazio, 2020b). The effects of repetition on belief have been shown with simple trivia statements (Hasher et al., 1977), true and false political news headlines (Pennycook et al., 2018), and advertising claims (Hawkins & Hoch, 1992). However, repetition has a larger effect on belief for trivia than for political or sensational health-related headlines (Pillai & Fazio, 2023). Recent research has shown that repetition affects belief across age groups (Brashier et al., 2017; L. K. Fazio & Sherry, 2020) and in real-world situations such as text messages (L. K. Fazio et al., 2022; Pillai et al., 2023). Moreover, repetition drives belief in an exponential manner, with the largest increases happening during the first few exposures (L. K. Fazio et al., 2022; Hassan & Barber, 2021)—suggesting that it is important to stop misinformation early before people are exposed multiple times.

A variety of individual differences affect susceptibility to misinformation (e.g., Nan et al., 2022). One strong predictor is the ability to process abstract information. For example, higher levels of education (e.g., Albarracín et al., 2021), analytical reasoning, and numeracy skills are negatively associated with endorsement of misinformation (e.g., Bronstein et al., 2019; Pennycook & Rand, 2019, 2020; Roozenbeek et al., 2020; Roozenbeek, Maertens, et al., 2022). People who reason well with numbers and score high on measures of metacognition (e.g., open-mindedness, reflection vs. intuition) tend to be better at distinguishing true versus false information (Mirhoseini et al., 2023; Saltor et al., 2023). Similarly, individuals who are overconfident in their ability to distinguish between true and false headlines are more likely to visit untrustworthy websites and more willing to like or share false content (Lyons et al., 2021).

Another commonly measured factor is age. Adults over 65 years old are much more likely than younger adults to see and share false information on social media (Grinberg et al., 2019; Guess et al., 2019, 2022). Yet, older adults are also better than younger adults at identifying misinformation and distinguishing between true and false news headlines, perhaps because of their larger knowledge base (Allcott & Gentzkow, 2017; Brashier & Schacter, 2020; Roozenbeek et al., 2020). This disconnect between sharing behavior and the ability to identify false news has yet to be explained, but it may involve several factors associated with older adults: poor digital literacy, greater trust, or communication goals that do not emphasize accuracy (Brashier & Schacter, 2020). (Differences in susceptibility based on minority status remain under-explored, and recent mapping of the illusory truth

literature has called for greater diversity in samples and methods [Henderson et al., 2022].)

Researchers have noted relatively small and inconsistent correlations between the Big Five personality inventory and susceptibility to misinformation (cf. Calvillo et al., 2021; Lawson & Kakkar, 2022; Roozenbeek, Maertens, et al., 2022). Anxiety levels can predispose individuals to believe misinformation (e.g., Albarracín et al., 2021), and a 5-decade cohort study from childhood to midlife found that vaccine-hesitant individuals reported greater trauma and adverse childhood experiences fostering mistrust (Moffitt et al., 2022).

Finally, many studies have found that conservatives in the United States were more likely than liberals to believe misinformation (e.g., Baptista & Gradim, 2022; Garrett & Bond, 2021). However, it is unclear whether conservatives are more psychologically vulnerable to misinformation (Pereira et al., 2021) or whether they are more heavily targeted by misinformation in the current information environment (Ditto et al., 2018; Guess, Lerner, et al., 2020).

IMPACT OF MISINFORMATION ON BELIEFS, ATTITUDES, INTENTIONS, AND BEHAVIORS

Establishing the impact of misinformation requires careful attention to whether outcome measures of impact are based on beliefs, attitudes, intentions, or behaviors. *Belief* is the judgment that an object is associated with specific attributes or outcomes (e.g., Ajzen et al., 2005; Albarracín, 2021; Albarracín et al., 2001). For example, a vaccine may be judged to be carelessly produced or to yield risky health outcomes. *Attitudes* are evaluations of outcomes or behavior as positive or negative (e.g., Albarracín, 2021; Albarracín, Johnson, et al., 2005; R. H. Fazio & Williams, 1986) that may be affected by beliefs about the object or behavior. For example, people may evaluate a vaccine favorably in part based on their belief that it saves lives. *Intention* (i.e., the willingness to perform a behavior) and *behavior* (i.e., the action itself) are often influenced by attitudes, past behavior, norms (i.e., the perception that others engage in or support a behavior), perceived behavioral control (Ajzen & Madden, 1986), behavioral skills (Bandura, 1986, 1991), and resources and facilitators in an environment (Azar et al., 2020; Bandura, 1986, 1991). Because multiple factors can influence outcomes such as vaccine uptake in a population, attitude–behavior relationship theory suggests that the association between belief in misinformation and behavior is likely to be small (Ajzen & Madden, 1986).

Estimating the impact of misinformation requires a high level of methodological control, which can be accomplished by three approaches. First, laboratory experiments that measure behavioral intentions are artificial but help to assess effects under conditions of forced exposure and low distraction. Second, longitudinal studies examine psychological changes over time under more natural conditions and can shed more light on the impact of belief in misinformation on behavior. Third, randomized controlled trials (RCTs) of information interventions provide important estimates of actual behavioral impact. In the following sections, we review evidence obtained using each of these methods.

Effects of Misinformation on Beliefs

The influence of misinformation on beliefs has been well established in both primary research studies and meta-analyses. These effects are typically very large across domains. For example, in laboratory experiments, exposure to misinformation had a large influence on recipients' beliefs (Chan et al., 2017). This large effect also occurred for misinformation that was specifically related to scientific findings or procedures (Chan & Albarracín, 2023).

Effects of Misinformation on Attitudes

The effects of misinformation on attitudes are considerably smaller than its effects on beliefs. One laboratory experiment showed that reading about a COVID-19 conspiracy theory (vs. receiving no information at all) had a detrimental effect on two attitudes: institutional trust and support for government regulations (Pummerer et al., 2022). Longitudinal studies based on existing belief in real misinformation led to similar conclusions, although the effect size was smaller. In a follow-up experiment to the one just described, Pummerer et al. (2022) found that those who initially believed COVID-19 conspiracy beliefs showed lower institutional trust and lower support for government regulations 2 months later. Another study found that stronger COVID-19 conspiracy beliefs at baseline were consistently associated with lower support for lockdowns 4 months later (van Prooijen, Amodio, et al., 2022). Based on these results, misinformation appears to have a modest overall effect on attitudes, particularly compared with the large effects observed on beliefs.

Effects of Misinformation on Intentions

Ecological surveys suggest a link between online misinformation and health-related behavioral intentions. In early 2021, the amount of COVID-19 vaccine-related misinformation

shared by Twitter users in a U.S. county predicted changes in the county's COVID-19 vaccine hesitancy rate 2 to 6 days later (Pierri et al., 2022). This analysis suggests that online misinformation affects the intention to vaccinate, but additional research is necessary to prove a causal relationship because regional studies can provide inaccurate characterizations of changes at the level of individuals.

Several experiments have further examined the impact of misinformation on health-related behavioral intentions. For example, participants who read an anti-vaccine conspiracy theory indicated that they were less likely to immunize a fictitious child against a novel disease (Jolley & Douglas, 2014). When Chinese young adults were exposed to conspiracy theories about the human papillomavirus vaccine, there was a small negative effect on intentions to receive it (L. Chen et al., 2021). In an RCT, exposure to five social media posts containing misinformation about the COVID-19 vaccine led to a small decline, in both the United Kingdom and the United States, in the number of people who would "definitely" vaccinate (Loomba et al., 2021).

Other studies, however, have shown mixed or scant results. Pummerer et al. (2022) showed that reading a COVID-19 conspiracy theory reduced intentions toward physical distancing, but it had a much smaller effect on intentions toward safe forms of social engagement (e.g., running errands for other people). Similarly, exposure to false information about vitamin E as a remedy for COVID-19 did not significantly increase people's willingness to pay for a vitamin E supplement (MacFarlane et al., 2021). Finally, a large online study examined the impact of a single exposure to misleading messages related to COVID-19 (e.g., vaccine complications, reduced symptoms with coffee consumption, reduced virus reproduction with spicy food intake, data safety concerns related to a contact-tracing app) on corresponding intentions (e.g., get the COVID-19 vaccine, drink more coffee, eat more spicy food, download the contact-tracing app). Exposure to the false information led to small reductions in intentions to vaccinate and download the app, but it had no effect on intentions to eat spicy food and slightly decreased intentions to drink coffee (C. M. Greene & Murphy, 2021). All in all, these experiments suggest that the average overall impact of misinformation on behavioral intentions is small.

Effects of Misinformation on Behaviors

Due to both the difficulty of accessing and measuring real-world behavior in some contexts (e.g., social media) and the ethical problems of introducing certain types of misinformation (e.g., health) to examine its effects, experimental studies on misinformation typically do not assess behavioral outcomes. However, based on the small effect sizes on risky intentions described in the preceding section, it is reasonable to estimate that the effect size of misinformation on behavior is also small.

Some longitudinal research has assessed effects of misinformation and conspiracy beliefs on behavior. For example, Wilson & Wiysonge (2020) looked at the impact of foreign disinformation via social media on overall vaccine uptake using global surveys and WHO vaccination data from 166 countries in 2000–2018. Year over year, they found that a 1-point increase on a 5-point disinformation frequency scale was associated with a drop of 2 percentage points in the average global vaccination rate.

Pummerer et al. (2022) measured the link between COVID-19 conspiracy beliefs and social distancing, safe social engagement, use of alternative medicine, and adoption of hygiene measures. Cross-sectional data showed a small average association between belief in a COVID-19 conspiracy and risky behavior, while the average effect for longitudinal data was even smaller. Similarly, van Prooijen, Amodio, et al. (2022) estimated these associations over two follow-ups and found a very small average effect. A meta-analysis of cross-lagged correlations from 17 samples found a small effect of conspiracy beliefs on behavior (Stasielowicz, 2022), and another meta-analysis yielded the same effect size (Bierwiaczonek et al., 2022). Interestingly, Stasielowicz (2022) also found a reciprocal effect of pandemic-related behavior on COVID-19 conspiracy beliefs: People's behavior predicted their later belief in conspiracy theories.

Finally, RCTs that investigate strategies to change health behavior can provide important insights on the likely impact of information on behavior. For example, a meta-analysis of condom-use promotion messages showed a strong effect on knowledge about HIV/AIDS but no effect on condom use. But, other interventions that included client-tailored counseling, behavioral skills training, or HIV counseling and testing produced stronger changes in behavior (Albarracín, Gillette, et al., 2005). Another meta-analysis of interventions to mitigate vaping misinformation identified a single study with an assessment of behavior, but the positive relationship between intervention and behavior change was not statistically significant (Janmohamed et al., 2022). When the same research group conducted a meta-analysis of interventions to mitigate COVID-19 misinformation, they found that only three reports measured behavior change, with an overall null

effect (Janmohamed et al., 2021). A recent systematic review of the effects of health misinformation on psychological outcomes found that misinformation negatively impacted psychological antecedents of health behavior (such as beliefs, attitudes, and intentions) in 49% of studies, but it found no reports directly measuring real-world health behaviors (Schmid et al., 2023). Finally, a meta-analysis of strategies to increase worldwide vaccination uptake showed no advantage of informational strategies (e.g., presenting correct information, dispelling misconceptions) relative to motivational ones (e.g., incentives). Only interventions that increased access and incentives boosted vaccination uptake beyond other strategies (Liu et al., 2023).

CASE STUDY 1: IDENTIFYING THE CONSEQUENCES OF MEDICAL MISINFORMATION

Although research studies often find relatively small effects of misinformation on real-world behavior overall, they can miss larger changes at the individual level. Anecdotes are colorful and memorable, but they cannot disentangle the different causes of a phenomenon.

There are many contemporary examples of individuals who changed a health-related behavior based on medical misinformation. Reports that show the impact of misinformation include parents who reject Tamiflu prescriptions and other medical treatments for their ailing children in favor of "natural cures" (Zadrozny, 2020), a man who died after ingesting a version of chloroquine used to treat disease in aquarium fish because he believed it to be the same as the anti-malaria drug falsely hyped as a COVID-19 cure (BBC News, 2020), and cellular phone towers in the United Kingdom that were vandalized in the wake of false rumors that the radio frequencies used in 5G wireless technology cause COVID-19 (Spring, 2020).

One especially prominent example of the community risk posed by misinformation is the outbreak of measles that spread through the Somali immigrant community in Minnesota in 2017. The community was concerned that their children were being diagnosed with autism, a diagnosis that was rare in Somalia. Anti-vaccine activist groups then targeted the community, spreading misinformation about the safety of childhood immunizations and promoting the false claim that the MMR vaccine causes autism (DiResta, 2018; Molteni, 2017). Immunization rates for young children of Somali descent in Hennepin County dropped from over 90% in 2008 to 36% in 2014 (Hall et al., 2017). The resulting measles outbreak infected 75 people before being contained (Minnesota Department of Health, 2017).

Misinformation can also have large consequences when it targets powerful people with decision-making authority. In the 1980s, the Soviet Union's government launched a disinformation campaign suggesting that the HIV virus was created by the U.S. government as a bioweapon. Similar rumors and conspiracy theories already existed, but this campaign provided additional specifics and wider distribution (Selvage, 2019). The rumor morphed over time, but the core idea that the U.S. government created HIV persisted (Nattrass, 2013). In 1999, the president of South Africa, Thabo Mbeki, delayed implementation of an antiretroviral treatment program due to his belief in HIV/AIDS misinformation; a year later, his health minister, Manto Tshabalala-Msimang, distributed a conspiracy theory text claiming that HIV was created in the United States as a bioweapon (Baleta, 1999; MacGregor, 2000). Researchers estimate that the delayed rollout of antiretroviral drugs in South Africa cost more than 330,000 lives (Chigwedere et al., 2008).

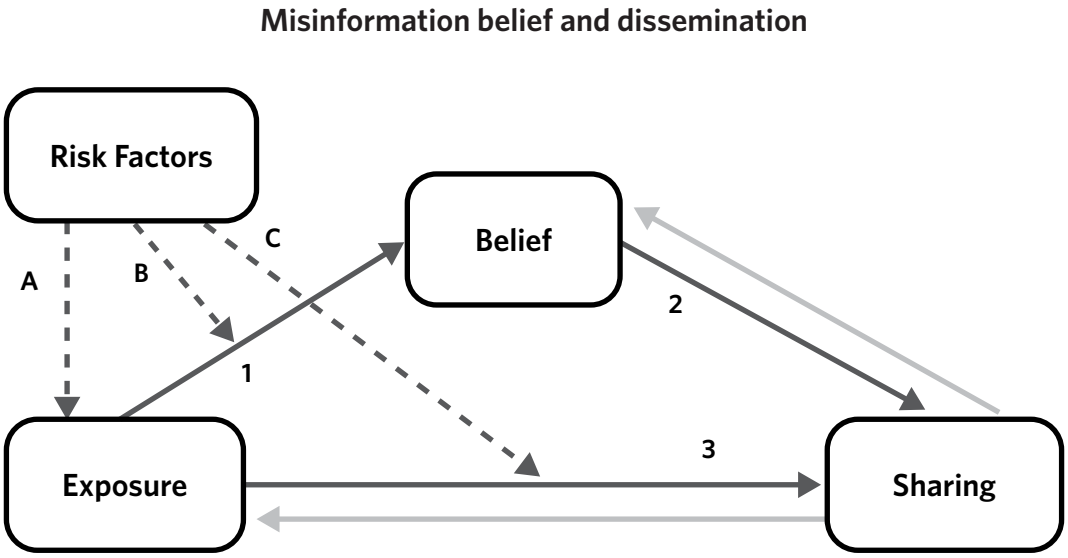
Growth: How and Why Does Misinformation Spread?

SOCIAL AND PSYCHOLOGICAL FUNCTIONS OF MISINFORMATION

Effective responses to misinformation require a detailed understanding of the social and psychological factors that drive people to adopt and spread it (e.g., Van Bavel et al., 2021; van der Linden, 2023). Fact-checking interventions, which are designed to detect and tag falsehoods, tend to be highly effective outside of political domains but not very effective within them (e.g., Walter et al., 2020), because people share misinformation for reasons beyond whether they believe it to be true. For instance, nudges that focus attention on the accuracy of information have small effects on intentions to share it (Pennycook & Rand, 2019; Roozenbeek, Freeman, & van der Linden, 2021), and they are less effective among political groups that spread the most misinformation (Rathje, Roozenbeek, et al., 2022). People may wish to share misinformation for several reasons, including to signal political views, defame opponents, generate chaos, or make money. Under these circumstances, they are less likely to value a story's veracity provided it furthers their agenda (e.g., Osmundsen et al., 2021). Therefore, it is critical to understand the individual-level risk factors that make people susceptible to spreading misinformation in the first place.

Figure 1 shows a model of the relationship between psychological risk factors and the spread of misinformation (Van Bavel et al., 2021). The model proposes that e*xposure* to misinformation increases *belief* (Path 1), which in turn increases *sharing* (Path 2). For instance, misinformation is more likely to be remembered as true (i.e., believed) when it is viewed repeatedly rather than just once (i.e., with rising exposure; Berinsky & Wittenberg, 2020). This path may also explain why some groups in society who are exposed to high levels of misinformation (e.g., U.S. conservatives) become more involved in its spread (i.e., sharing; González-Bailón et al., 2023; Guess et al., 2019, 2022). At the same time, people may share misinformation independently of whether they believe it (Path 3; Pennycook & Rand, 2021). For instance, people willingly spread misinformation that they know is false when they expect to receive social rewards (Ren et al., 2022) or because they think it is otherwise interesting (Altay, de Araujo, & Mercier, 2022) or entertaining (van Prooijen, Ligthart, et al., 2022).

Figure 1. A model of misinformation belief and spread. *Exposure* to misinformation increases *belief* (Path 1) and, in turn, increases *sharing* (Path 2). Exposure can also increase sharing directly without affecting belief (Path 3). Psychological risk factors can increase the likelihood of exposure to misinformation (Path A); they can also affect its impact on belief (Path B) and sharing (Path C). We also propose reverse pathways for future study (gray arrows). From Van Bavel et al. (2021).



The model also describes how *psychological risk factors* can increase exposure to misinformation (Path A) and modulate its impact on belief (Path B) and sharing (Path C). (There may also be reverse paths pending further study; see gray arrows.) According to Van Bavel et al. (2021), "When one individual shares misinformation, it increases exposure to misinformation among other people in their social network. This, in turn, increases the likelihood that these new individuals will believe and share the information with their own social networks" (p. 87). In online environments, this spread can unfold rapidly and have far-reaching consequences for exposure to misinformation. It is important to understand that the spread of misinformation includes not only intentionally and unintentionally inaccurate news but also conspiracy theories, disinformation campaigns, propaganda, and slanted or biased reporting intended to mislead the public. The psychological model discussed here is relevant to the belief and dissemination of all of these forms of misinformation; we refer to affected paths in the sections that follow.

PSYCHOLOGICAL FACTORS DRIVING ENGAGEMENT WITH MISINFORMATION

Partisanship

When facts contradict a person's beliefs, reason indicates that they should update or change those beliefs—but that does not always happen. In fact, psychologists have observed that people maintain certain beliefs long after contrary evidence proves them false (Path B; e.g., Ross et al., 1975). There are limits to this resolve: *Backfire effects*, in which people double down on their initial beliefs when they are refuted, are fairly rare (e.g., Swire-Thompson et al., 2020, 2022; Wood & Porter, 2019). But, when information aligns with a cherished identity or worldview, people tend to interpret it in a biased manner that reinforces original predispositions. This effect is called *partisan bias* (Meffert et al., 2006). If the value that people place on their identity is higher than the value that they place on accuracy, it can lead them to believe and spread misinformation (Rathje, Roozenbeek, et al., 2022; Van Bavel & Pereira, 2018). Partisan bias can arise from selective exposure to news; it can also stem from the underlying goals and needs of the individual (i.e., motivated cognition; e.g., Festinger, 1957; Kunda, 1990).

Political views can lead partisans to either accept misinformation or dismiss accurate news as false (Path B; Schulz et al., 2020). In the United States, both Democrats and Republicans were more likely to believe and share false stories that reflected positively on their party and those that reflected negatively on their opponents (Pereira et al., 2021). Similarly, the most important variable predicting whether readers found a false news article misleading was the partisan alignment of the news source with their identity (Aslett et al., 2020; Guess et al., 2022; Traberg & van der Linden, 2022). In fact, a recent study found that this "myside bias" was more prominent than lack of numeracy or cognitive reflection skills in predicting susceptibility to misinformation (Roozenbeek, Maertens et al., 2022).

Partisan bias and motivated cognition have been observed for a wide variety of contexts and tasks across the political spectrum (e.g., Ditto et al., 2018; Mason, 2018) in the United States (Campbell et al., 1960; Druckman, 2012; Kam, 2005) and abroad (Brader et al., 2012, 2020; Carlson, 2016; Coan et al., 2008; Samuels & Zucco, 2014). A recent analysis found that partisan-motivated cognition (Van Bavel & Pereira, 2018) was the best model to account for misinformation sharing (e.g., Borukhson et al., 2022). Misinformation flourishes during periods of heightened polarization, including the run-ups to elections (Silverman, 2016), so polarization elevates risk across all stages of our model.

Even when information is implausible or clearly false, extreme partisans may choose to spread it to support their in-group or destabilize their opponents (Path C). A recent study of over 2,000 U.S. Twitter users sharing more than 2 million posts found that the strength of partisan identity predicted how likely a person was to share astory from an illegitimate source. Sharing behavior was driven more by a person's negative feelings toward their out-group party than by positive feelings toward the party to which they belonged. These findings suggest that people who share information in polarized environments care less about its accuracy and more about its alignment with their partisan beliefs (Osmundsen et al., 2021; see also Rathje et al., 2021).

In many cases, people avoid sharing misinformation because they feel that doing so could harm their reputation (Altay et al., 2019). However, individuals with strong political views update their beliefs based on cues from both political leaders and peers (Hahnel et al., 2020; see also Zawadzki et al., 2020), and social norms operating within communities appear to moderate belief and trafficking in misinformation (Pretus et al., 2023). Similar patterns of belief in misinformation were observed among Democrats and Republicans (Path B), but the difference is that Republicans showed far more willingness to share it (Path C; Guess et al., 2019; Guess, Nyhan, & Reifler, 2018, 2020; Pereira et al., 2021). One inter-

pretation of these data is that sharing misinformation is a normative social behavior for U.S. Republicans, or that no countervailing norm is present to discourage it (e.g., reputational harm). These findings may also reflect differences in other social traits observed between the two parties (e.g., conformity, shared experience; Jost et al., 2018).

Emotion

Another contributing factor in the belief and spread of misinformation is emotion. One study analyzed over 125,000 news stories shared on Twitter by ~3 million people from 2006 to 2017; its main finding was that misinformation diffused deeper, faster, and farther than fact-checked true information. For example, the top 1% of false news cascades reached 1,000 to 100,000 people, but verifiably true news cascades rarely reached more than 1,000 people. This effect was observed across a variety of topics (e.g., urban legends, business, terrorism, science, entertainment), but it was especially strong for news about politics (Vosoughi et al., 2018).

Of particular note, misinformation was rated as more novel than true information when compared with tweets users had seen in the past—which suggests that people tend to *believe* news that they have seen previously, but they actually *share* novel news (Path C). Misinformation also elicited greater surprise, fear, and disgust than did true information (Vosoughi et al., 2018), consistent with experiments in which induced emotional states were associated with increased belief in inaccurate news (Path B; Martel et al., 2020). One caveat is that critics of Vosoughi et al. (2018) claimed that their results generalize poorly because the analysis involved fact-checked news and most news is not fact-checked. However, the authors replicated their findings with news that was not fact-checked, and other studies have validated their results (e.g., Juul & Ugander, 2021). That said, recent work indicates that social media diffusion patterns vary with the specific platform used (cf. Cinelli et al., 2021), so further study is warranted.

Nonetheless, a recent systematic review of the literature on health misinformation found that "misinformation contained more emotion-based arguments and rhetoric compared to factual information" in 14 of the 15 included studies (Peng et al., 2023, p. 2137). Overall, these findings indicate that novelty and emotion help to sustain misinformation.

CASE STUDY 2: *PLANDEMIC*

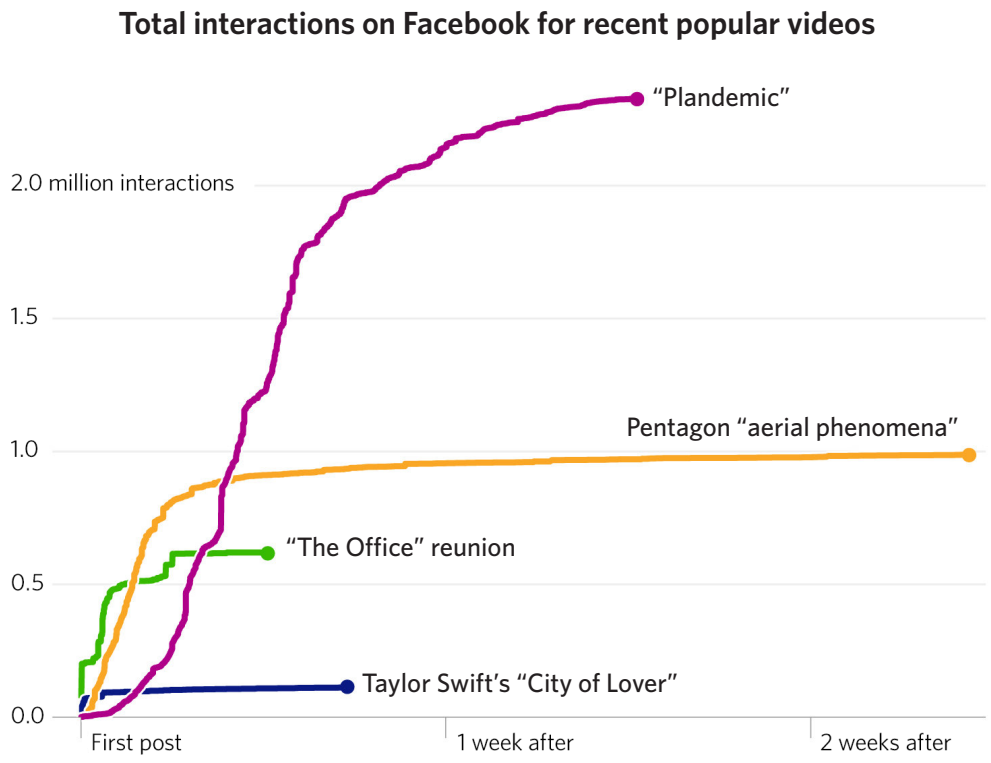
In 2020, in the midst of the COVID-19 pandemic, the 26-minute conspiracy film *Plandemic: The Hidden Agenda Behind COVID-19* was released. In the video, many influential but false claims were advanced, including that "wearing a mask literally activates your own virus," that "flu vaccines contain coronaviruses," and that "hydroxychloroquine is effective against COVID-19" (Funke, 2020).

After the video was posted online, it was quickly endorsed by fake experts, politicians, and other influencers and spread rapidly on social media, reaching over 2.5 million interactions on Facebook and 7 million views on YouTube before it was removed from the platforms just a few days later. As Figure 2 shows, the *Plandemic* video spread online faster than mainstream news such as the announcement of Taylor Swift's *City of Lover* concert and the much-anticipated Zoom reunion of the popular television show *The Office* (Frenkel et al., 2020). (Two sequels failed to gather similar momentum.)

Subsequent research suggests that the *Plandemic* video was able to spread so quickly for two reasons. First, the film presented novel and emotional "shock" content that tapped into preexisting anti-vaccination attitudes. Second, the campaign herded a densely connected network of smaller communities with limited reach to suddenly mass-share the video, which allowed the conspiracy theory to jump quickly across social media platforms with the aid of online influencers.

Although the film's claims were widely debunked, research shows that it increased engagement with anti-vaccination tweets, fueled politically polarized discussions, and temporarily lowered support on social media for COVID-19 containment measures (Kearney et al., 2020; Nazar & Pieters, 2021).

Figure 2. Cumulative interactions on Facebook (e.g., reactions, likes, shares, comments) for the conspiracy film *Plandemic: The Hidden Agenda Behind COVID-19* compared with other popular videos released during the same period. From Frenkel et al. (2020).



MISINFORMATION SPREAD ON LEGACY AND SOCIAL MEDIA

Both legacy media and social media are powerful vectors for the transmission of misinformation. However, misinformation spreads at different speeds and volumes within each system.

Legacy Media

The term "legacy media" refers to television, radio, film, books, newspapers, and other analog media widely available during the 20th century, along with their online presences. Mainstream news outlets in television, radio, and print—which disseminate more health-related content than other forms of legacy media—generally adhere to traditional journalistic values such as accuracy, neutrality, timeliness, and editorial independence. Most news operations implement multiple layers of error correction to reduce false information in published content and archival records: Editors and fact-checkers review articles for errors and inconsistencies prior to publication, and errors discovered after publication are corrected with an addendum at the beginning or end of the report.

One way in which news outlets spread misinformation is through errors that squeeze past these safeguards. Many such errors are minor, but others have the potential to carry serious consequences. For instance, an Associated Press story about the arrival of Chinese-produced COVID-19 vaccines in Hungary stated "This story has been corrected to show that about 500,000 people have been vaccinated in Serbia, including ethnic Hungarians, not 500,000 ethnic Hungarians" (Spike, 2021). The suggestion that certain ethnic groups are preferred for vaccination or withheld from it, or that vaccines are made available in some areas but not others, could fuel vaccine-related conspiracy theories (e.g., Albarracín et al., 2021). Indeed, prominent Fox News host Tucker Carlson claimed in 2022 that White Americans were being denied anti-COVID-19 treatments because of their race (Lahut, 2022). The Associated Press example shows how even unintentional misstatements could harm citizens and their communities. However, little research has been conducted on how often routine factual errors in the news contribute to false beliefs.

Journalists can abet the agendas of those who deliberately spread misinformation. *The New York Times* quoted Joseph Mercola in an article about the possible negative health effects of mobile phones (Bilton, 2015), which was criticized because Mercola has long promoted false health

claims with the books and alternative health treatments that he sells (Frenkel, 2021; Sullivan, 2015). Similar incidents have been observed in celebrity-focused "soft" news (Bruns et al., 2022) and sometimes originate in media manipulation campaigns by bad-faith actors (Benkler et al., 2018; Marwick & Lewis, 2017). False claims spread or repeated by trustworthy or mainstream outlets are likely to cause more damage than those promoted by fringe sources (Traberg, 2022; Tsfati et al., 2020). Health and medical reporters generally avoid being misled by relying on medical professionals with proven track records of scientific expertise; sometimes this approach is unsuccessful, as with widespread coverage of the spurious link between the MMR vaccine and autism (Burgess et al., 2006; Clarke, 2008; Lewis & Speers, 2003).

Social Media

Unlike legacy media, social media lacks prepublication oversight as an industry standard to ensure information quality (although some organizations have begun to institute safeguards; e.g., Kreiss, 2016). Indeed, the medium's rapid publication speed, built-in distribution networks, and extremely low barriers to entry constitute its main advantages. The fact that social media content can go viral within minutes is an attractive quality for purveyors of both legitimate content and misinformation. In the latter case, falsehoods usually reach far more people than any fact-checks or corrections that follow (Vosoughi et al., 2018; cf. Bond & Garrett, 2023).

Social media's low barriers to entry contribute substantially to its appeal for producers of misinformation. Before publishing in legacy media outlets, authors are vetted at multiple points; in journalism, these include the hiring process, the pitch process, and the editorial process. Social media, on the other hand, affords content creators direct access to audiences in a way that mainstream news outlets do not. Because anyone with internet access can post on social media within minutes, misinformation can usually be policed only after the fact. This is perhaps the main reason why popular misinformation creators hail the power of social media to monetize their efforts (A. Smith & Banic, 2016).

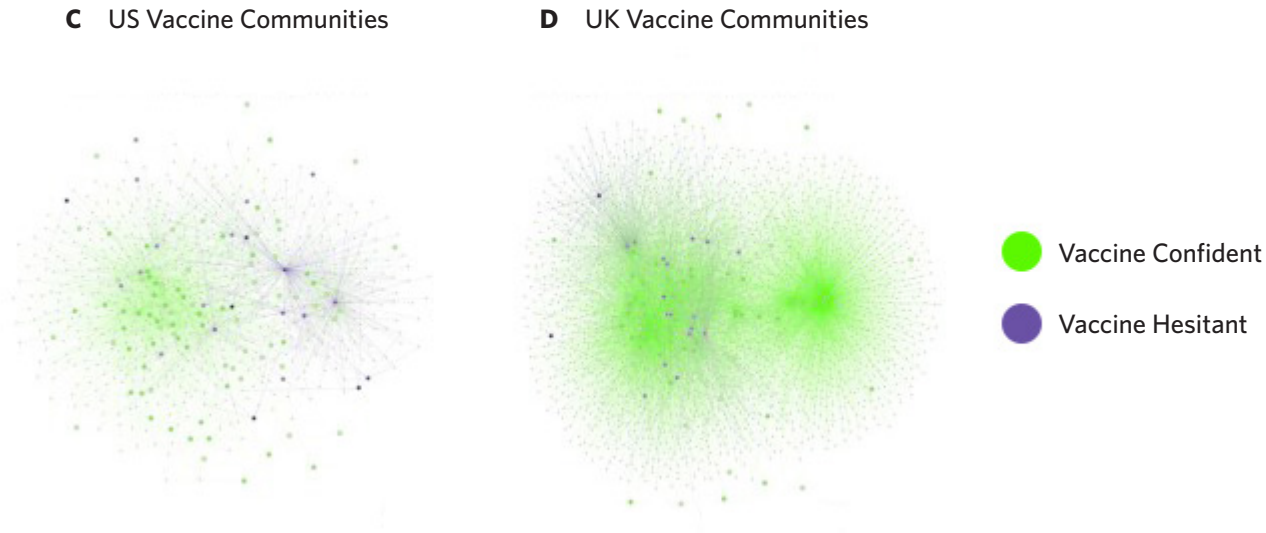
Social media platforms also facilitate the spread of misinformation through peer-to-peer content-sharing. Their low-friction network structures allow ordinary users to distribute misinformation to much larger audiences than their creators ever could on their own. This idea is especially important because one of the major paths to viral visibility is through trusted influencers such as celebrities and prominent politicians (Brennen et al., 2020; I. Shin et al., 2022). When influencers share messages containing misinformation, they also convey the impression that they endorse the misinformation—or at least believe it worthy of consideration (Metaxas et al., 2015). A similar effect follows when we view content from ordinary people we know and trust: We are much more likely to take what they share seriously than we would content originating from unknown sources (Rossini et al., 2021).

The third major way that social media enables the spread of misinformation is via echo chambers and algorithmic filtering. *Echo chambers* occur when there is both homophily (i.e., "birds of a feather flock together") and polarization in a network, which makes communities with similar beliefs or interests cluster together while moving away from those that differ. The echo chamber hypothesis posits that online users mostly interact with like-minded others and are infrequently exposed to diverse or cross-cutting content. (Polarization can be both a cause and a consequence of echo chambers.)

Numerous studies have shown that echo chambers exist within specific social media platforms (e.g., Cinelli et al., 2020; Del Vicario et al., 2016), though scholarly debate has erupted over their prevalence and boundaries; for example, some reports have found substantial overlap in the news intake of liberals and conservatives (Eady et al., 2019). A recent systematic review of the echo chamber hypothesis (Terren & Borge-Bravo, 2021) suggests that the ability to identify echo chambers depends on the method used: Only five of 55 studies found no evidence of echo chambers, and all five studies were based on self-reported rather than digital trace data. However, most of the digital trace studies sampled (44 of 55) relied on data from only one social media platform, and reviews of multiplatform studies continue to raise important questions about prevalence and impact (Bruns, 2019; Cinelli et al., 2021; Guess, Nyhan, Lyons, & Reifler, 2018).

Digital trace studies have demonstrated that people tend to separate into homophilic clusters when discussing specific political issues online on specific platforms. Survey studies, on the other hand, show that people tend not to create personalized, segregated information environments based on their total media intake (Boulianne et al., 2020; Dubois & Blank, 2018; Fletcher et al., 2021). Nonetheless, the presence of social media echo chambers may depend on the specific platform and context. Few studies have combined survey and social media data, but a recent analysis found clear evidence that pro-vaccination and anti-vaccination groups clustered into structurally separate communities on Twitter in the United States but not in the United Kingdom, as shown in Figure 3 (Rathje, He, et al., 2022).

Figure 3. Visualization of vaccine confident vs. vaccine hesitant echo chambers in the United States and the United Kingdom. From Rathje, He, et al. (2022).



Despite these diverging conclusions, evidence indicates that the presence of social media echo chambers can facilitate the spread of misinformation (Del Vicario et al., 2016; Törnberg, 2018) and impede the spread of corrections (Zollo et al., 2017). *Algorithmic filtering* may also play a role: Most social media platforms use filters based on engagement data to determine or prioritize what content to show users; these data include the numbers of clicks, shares, and comments that posts receive overall, as well as users' individual platform interaction histories (Maréchal & Biddle, 2020). Content that exhibits negative emotions such as anger and outrage tends to attract engagement (Brady et al., 2020; Rathje et al., 2021), and misinformation messages often fit this profile (Lee et al., 2020; McLoughlin et al., 2021; Solovev & Pröllochs, 2022). Social media platforms also commonly promote misinformation messages to users who initially seek out such content (Hussein et al., 2020; Shin & Valente, 2020). A recent systematic review of YouTube's algorithm found that 14 of 23 studies (61%) directly implicated the algorithm in recommending problematic content (Yesilada & Lewandowsky, 2022), but other studies question the extent to which algorithmic filtering plays a role (e.g., Hosseinmardi et al., 2021). Many studies in this area lack access to individual user recommendations due to trade secrecy (but see S. Chen et al., 2023), so our ability to fully understand the issue remains limited.

NETWORK STRUCTURE AND MISINFORMATION SPREAD

The world of legacy media was one in which a very small number of media creators decided what mass audiences would see and hear. Digital media has redistributed this power somewhat, although the set of individuals whose content is viewed widely is still quite small (Hindman, 2009). The digital communication networks used by most people today can be divided into two broad types: open and closed. Open networks impose few access requirements aside from internet connectivity and, in some cases, signing up for an account. Closed networks are more like private clubs, requiring some form of prior approval before messages can be viewed and/or posted. Many social media systems offer both open and closed options: Facebook and Twitter users can post messages publicly or to private "groups" (on Facebook) or "circles" (on Twitter). In messaging apps (e.g., iMessage, WhatsApp, Signal, WeChat), messages are circulated exclusively within prespecified members-only groups.

Misinformation spreads differently across open versus closed networks (Pasquetto et al., 2022; Rossini et al., 2021). These differences can be classified into two broad categories: those related to differences in platform design, and those not necessarily related to platform design but observed empirically. One of the most consequential design differences between open and closed systems is the latter's use of end-to-end encryption (E2EE). This security protocol is built to ensure that the only parties who can read a sender's message are the sender and the intended recipients. (Of the most widely used messaging platforms, iMessage, WhatsApp, and Signal use E2EE, but WeChat does not.) It is impossible for E2EE-based

platform companies to police misinformation on their own, although users may report accounts that spread problematic content, which may lead to disciplinary action against those accounts. WhatsApp has partnered with fact-checking organizations to provide "tiplines" to which users can forward suspicious messages for verification (Kazemi et al., 2022); partners respond to senders with reports on the truth or falsehood of the claims—but importantly, the claims themselves remain visible. Aside from tiplines, users concerned about misinformation may withdraw from groups where it thrives or block accounts that post it. In completely hands-off closed networks such as iMessage, steps like these are users' sole recourse.

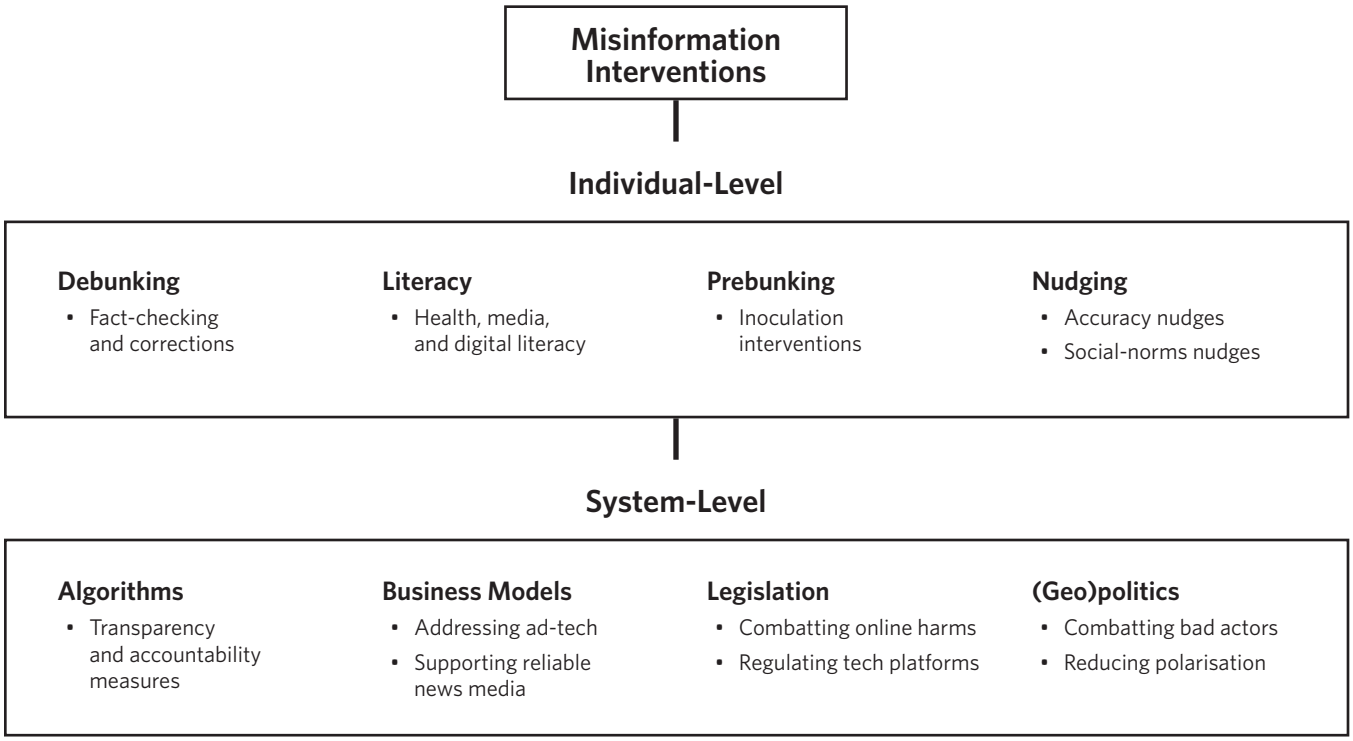
In contrast, the increased visibility of open networks allows their parent companies to directly stem the spread of misinformation by deleting or labeling it. This ability is important because in open networks (but not closed ones), content can be shared widely across vast social distances. In open networks, misinformation often attracts widespread attention before it is flagged for removal (e.g., Maréchal & Biddle, 2020). But, users can also fact-check it across ideological lines much more easily than in closed networks, in which generally like-minded groups are not easily surveilled by outsiders (Pasquetto et al., 2022; Yarchi et al., 2021).

Technical considerations aside, empirical research has highlighted similarities and differences in how misinformation spreads in open versus closed networks. In both, misinformation usually constitutes only a minority of messages (Chauchard & Garimella, 2022; Grinberg et al., 2019; Guess et al., 2019; Machado et al., 2019; Röchert et al., 2021). However, messages may surge at the onset of a public health event, well before the facts are settled (Kouzy et al., 2020; Ortiz-Martínez et al., 2022). Another similarity between open and closed networks is that a small number of accounts and groups (i.e., "superspreaders") are typically responsible for the majority of misinformation content (Center for Countering Digital Hate, 2021; Grinberg et al., 2019; Nobre et al., 2022). Meanwhile, a few studies have revealed differences between platform types, especially regarding corrections to misinformation. WhatsApp users "are more likely than Facebook users to perform, experience, and witness social corrections" (Rossini et al., 2021, p. 2446), and they are more likely to share misinformation-debunking messages from people close to them or those with similar political views (Pasquetto et al., 2022). In contrast, debunking messages on open networks can take up to 7 days to proliferate to the same extent as misinformation, during which time false information spreads unchallenged (McGlynn et al., 2020).

Response: Interventions to Counter Misinformation

In recent years, researchers have explored how to manage and prevent exposure to misinformation, belief in it, and the subsequent sharing of it. Roozenbeek et al. (2023) have identified two dimensions of misinformation interventions, shown in Figure 4: *System-level* approaches focus on achieving systemic changes (e.g., legislation, transparency standards; see also Roozenbeek & Zollo, 2022), and *individual-level* approaches focus on changing individual behavior. In this section, we focus on individual-level interventions that have been empirically tested and evaluated. We first look at interventions that target *competencies* such as the ability to identify false or misleading information (e.g., debunking, inoculation or "prebunking," health and media/digital literacy). We then turn to nudging interventions, which target *behaviors* such as the sharing of misinformation with others on social networks. Each of these interventions can be deployed under different circumstances and brings unique advantages and disadvantages; we discuss laboratory and real-world evidence of efficacy as well as limitations that warrant further study.

Figure 4. An overview of individual-level and system-level misinformation interventions. From Roozenbeek et al. (2023).



It is possible that system-level interventions could be more effective than individual-level ones in curbing the spread of misinformation—for example, by reducing the harmful effects of recommender algorithms, demoting misinformation in online search platforms and social media, or removing content in predatory journals from medical databases (Swire-Thompson & Lazer, 2022). However, individual-level interventions have fewer potential ramifications for freedom of expression, and they rely less on the ability and willingness of technology companies to combat harmful content. (For a more extensive discussion of the system-level and individual-level interventions shown in Figure 4, see Kozyreva et al., 2022; Roozenbeek et al., 2023; Roozenbeek & van der Linden, 2022.)

DEBUNKING

Debunking or fact-checking is the correction of misinformation (Lewandowsky et al., 2020); it also involves addressing why the misinformation is incorrect and/or providing accurate information (Ecker et al., 2022). This intervention is deployed after people have been exposed to misinformation

and believe it or are unsure of its veracity. It is also useful for people who already know that the misinformation is false, as it gives them additional information to understand the concept more thoroughly or share it more easily with others.

Efficacy of Debunking

The effect size of debunking is typically large (Chan et al., 2017). However, a recent meta-analysis of science-relevant misinformation (including health) found that corrections were, on average, not effective (Chan & Albarracín, 2023), though the average masks substantial variation in effectiveness across studies and designs. Findings are mixed as to whether health misinformation is easier to correct than political misinformation (Chan & Albarracin, 2023; Vraga et al., 2019), but Walter and Murphy (2018) posit that health misinformation may be easier to correct because topics that involve political identity are especially resistant to belief change. Yet, it is worth noting that health is becoming an increasingly politicized issue (e.g., COVID-19). Although simply stating that misinformation is false can be effective, debunking is most effective when a detailed reason is offered to explain why the misinformation is incorrect. Often called a "refutation," this more descriptive approach can be used to explain the falsehood and replace it with facts (Chan & Albarracín, 2023; Ecker et al., 2010; van der Meer & Jin, 2020).

Debunking appears to be effective in real-world settings and across various cultures. For instance, Porter and Wood (2021) found fact-checks to be effective in Argentina, Nigeria, South Africa, and the United Kingdom. Researchers were initially concerned that debunking could cause backfire effects in which corrective efforts *increase* belief in the misinformation; Nyhan and Reifler (2015) and Pluviano et al. (2017) found that corrections to vaccine misinformation *reduced* intentions to vaccinate. However, this phenomenon has been difficult to replicate (Haglin, 2017) and is likely a statistical artifact that reflects the unintended consequence of using unreliable measures (Swire-Thompson et al., 2020, 2022).

It also seems that debunking is extremely robust to variations in how the correction is presented. Evidence suggests that corrections were equally effective regardless of their tone (i.e., uncivil, affirmational, or neutral; Bode & Vraga, 2021), whether the correction appeared to be from an algorithm or another user on social media (Bode & Vraga, 2018b), or where the corrections were presented (i.e., the "related articles section" of a social media platform; C. N. Smith & Seitz, 2019). It appears that simply getting people to interact with corrections is the most important component of a successful debunking strategy, particularly if the corrections come from trusted sources (Bode & Vraga, 2018a). In healthcare, many workers are professionally motivated to correct misinformation on social media (Bautista et al., 2021), and reputable sources of health information (e.g., CDC) have become more proactive with fact-checking on their websites and social media. Data show that expert health organizations are able to correct misinformation without reputational cost (Vraga & Bode, 2017).

However, some debunking advice has less clear empirical support. One common debunking approach is to present the fact prior to the misinformation, or as a "truth sandwich" in which true information is stated twice with the falsehood between. The rationale for this strategy is that emphasizing the factual information leads false information to be processed within the context of true information. Although this approach has some empirical support (König, 2023), it does not necessarily perform better than other debunking formats (Kotz et al., 2023). Swire-Thompson et al. (2021) examined the effect of presentation order (i.e., misinformation-first vs. fact-first) on belief updating, and they also found no difference between the outcomes of misinformation-first and fact-first corrections.

Few studies on fact-checking include long-term measures of efficacy (Dias & Sippitt, 2020). It is well documented that the new knowledge acquired with debunking fades over time, a phenomenon known as "belief regression" (Swire-Thompson et al., 2023). However, Kowalski and Taylor (2017) showed that debunking remained partially effective and did not return to baseline for up to 2 years. Some health-related fact-checks have been found to return to baseline (Carey et al., 2022); this is more likely when people do not strongly believe the misinformation to begin with. The primary reason that belief regression occurs is that people forget the correction (Swire-Thompson et al., 2022) or that the source of the correction is credible (Albarracín et al., 2017). Thus, repeated fact-checks may be particularly effective.

Limitations of Debunking

A primary limitation of debunking is that it does not fully eliminate the influence of misinformation on one's memory. Although corrections typically *reduce* belief in misinformation, it is not to the same extent as for people who never encountered the misinformation in the first place. Known as the "continued influence effect" of misinformation (Chan et al., 2017; Lewandowsky et al., 2012; Walter & Tukachinsky, 2020), this robust phenomenon occurs either because people fail to fully integrate the correct information into their mental

model or because they fail to retrieve the correct information in memory (Ecker et al., 2022; Sanderson & Ecker, 2020).

A second limitation is that fact-checks often fail to reach their intended targets (Zollo et al., 2017), in part because individuals who are predisposed to believe in the original misinformation actively avoid its correction (Hameleers & van der Meer, 2019). This finding is true for misinformation in both online and offline environments. For example, Chido-Amajuoyi et al. (2019) investigated the reach of court-ordered statements, in print and on television, made by the tobacco industry to correct misinformation regarding smoking. They estimated that 41% of the U.S. population and 50% of U.S. smokers were exposed to the corrections (see Case Study 3); another study showed that little to no social media engagement came of these efforts (Kostygina et al., 2020). Debunking strategies that use popular content creators may increase the visibility and reach of fact-checks.

Finally, fact-checking is a time-consuming process in which each misconception is examined individually, so there is an asymmetry between how quickly misinformation can be produced and spread and how quickly people can fact-check it (Allen et al., 2021). Allgaier and Svalastog (2015) also highlight that debunking may not be a one-size-fits-all approach and may not be equally effective for every population. They suggested that if fact-checks were developed with broader cultural, historical, and political contexts in mind, they may be more effective.

CASE STUDY 3: CORRECTING TOBACCO MISINFORMATION

In 2006, U.S. District Judge Gladys Kessler ordered several tobacco companies to issue statements confirming the adverse health effects of smoking and its addictive potential, correcting decades of denial by the tobacco industry (United States v. Philip Morris USA, Inc., 2006). Corrections were displayed in major newspapers, on television, at retail point-of-sale displays, on cigarette-package inserts, and on corporate websites.

There has been substantial research regarding the efficacy of this campaign. The corrections had a positive effect on anti-smoking beliefs (Tangari et al., 2010), and they increased participants' knowledge and reduced their misperceptions about smoking (P. Smith et al., 2011). However, Lee et al. (2020) found that the corrective messages could have been strengthened had they included a statement acknowledging industry deception and testimonials of people harmed by smoking.

It is also important that campaigns to correct misinformation maximize their reach. Chido-Amajuoyi et al. (2019) estimated that corrective statements reached 50% of U.S. smokers, but exposure was lower for younger age groups: Only one-third of 18- to 34-year-old smokers saw the messages. In response, the authors recommended placing anti-smoking advertisements on social media in addition to print and television. They also recommended increasing the duration of anti-smoking efforts, as the study found that exposure rates significantly improved for all demographic groups as the advertising campaign's duration lengthened.

PREBUNKING AND PSYCHOLOGICAL INOCULATION

Preemptive debunking, or *prebunking*, is an umbrella term for a category of interventions intended to prevent people from believing future misinformation attempts. The method most commonly used to prebunk misinformation is psychological inoculation. According to inoculation theory (Compton et al., 2021; McGuire, 1964; McGuire & Papageorgis, 1961; van der Linden, 2023), exposure to a weak version of an argument builds psychological resistance against future unwanted persuasion. This strategy is similar to that used in medical vaccines: Weakened or dead pathogens prompt the immune system to create antibodies that build resistance against future infection. Psychological inoculations have two parts: a forewarning about an impending attack on a belief (e.g., "Warning: People may try to manipulate you by saying . . .") and a statement that preemptively refutes the argument (e.g., "This is not true, because . . ."). In the context of misinformation, there are two dominant types of inoculation interventions: *Issue-based* interventions tackle individual arguments or stories that are false, and *technique-based* interventions address the common tropes and techniques that underlie misinformation (e.g., logical fallacies, emotional manipulation, conspiratorial reasoning; Compton et al., 2021; Traberg et al., 2022).

Within inoculation research, there is one additional relevant distinction, namely between *passive* and *active* inoculation (McGuire, 1964; Traberg et al., 2022). Passive inoculation interventions offer participants a preemptive counterargument to misinformation, while active inoculation interventions ask participants to generate their own counterarguments. Passive inoculation interventions can be text-based (Basol et al., 2021; Cook et al., 2017) or video-based (Lewandowsky & Yesilada, 2021; Piltch-Loeb et al., 2022; Roozenbeek, van der Linden, et al., 2022). Active inoculation interventions often come in the form of a game or quiz (Cook et al., 2022; Roozenbeek & van der Linden, 2019).

Text-based inoculations include interventions such as the United Nations Economic, Scientific, and Cultural Organization's #ThinkBeforeSharing infographics about COVID-19 conspiracies (UNESCO, 2020; see also Basol et al., 2021); other text-based inoculation interventions around health were tested by Ivanov (2017) and Compton et al. (2016). With respect to videos, Roozenbeek, van der Linden, et al. (2022) and Lewandowsky and Yesilada (2021) created short inoculation videos that tackle various persuasion techniques commonly used in misinformation (such as scapegoating and appeal-to-emotion fallacies), and Piltch-Loeb et al. (2022) focused on health-related misinformation with a series of videos showing how to spot misleading tactics in vaccine misinformation. Examples of inoculation games include *Bad News*, which helps players recognize common misinformation tactics (Roozenbeek & van der Linden, 2019); *Harmony Square*, which focuses on political misinformation (Roozenbeek & van der Linden, 2020); and *Go Viral!*, which prebunks misinformation about COVID-19 (see Case Study 4; Basol et al., 2021).

Efficacy of Prebunking

Inoculation interventions have been shown to be effective at reducing susceptibility to both individual examples of misinformation (e.g., van der Linden et al., 2017; Williams & Bond, 2020) and various manipulation techniques (Traberg et al., 2022). Successful prebunking has occurred with text-based (Cook et al., 2017; Green et al., 2022), video-based (Piltch-Loeb et al., 2022), and game-based interventions (Basol et al., 2021; Cook et al., 2022; Roozenbeek, Traberg, & van der Linden, 2022). For instance, Piltch-Loeb et al. (2022) found that their inoculation videos improved people's recognition of misinformation tactics, reduced their willingness to share misinformation with others, and increased their willingness to get vaccinated against COVID-19. A recent systematic review and meta-analysis found that inoculation interventions are effective in creating more resistant attitudes against misinformation while improving truth discernment (Lu et al., 2023). There are few reports that directly compare passive versus active inoculation interventions, but the studies that do exist somewhat favor active inoculation in terms of effect size and longevity (Basol et al., 2021; Green et al., 2022). A recent systematic review also revealed that prebunking interventions had larger effect sizes than debunking interventions for countering conspiracy theories, noting that "prevention is the best cure" (O'Mahony et al., 2023, p. 14).

Maertens et al. (2020, 2021) and Basol et al. (2021) looked at the long-term effects of inoculations. All three studies found that intervention effects that dampen the perceived reliability of misinformation remained significant for at least 1 week and in some cases longer; they lasted up to 3 months or more when people were given brief reminders of the inoculation (so-called "booster shots").

Limitations of Prebunking

Inoculation interventions are "boosts" (Hertwig & Grüne-Yanoff, 2017) in that they seek to improve certain competencies, such as the ability to identify misinformation. Thus, people have to opt in to participating in the intervention (e.g., watching a game, playing a video). Cross-cultural testing is lacking, especially in countries outside North America and Western Europe (but see Badrinathan, 2021; Harjani et al., 2023; Iyengar et al., 2022), yet interventions need to be designed with audiences in mind in order to be most effective (Ali & Qazi, 2023). There is also a lack of real-world prebunking campaigns. In a field study on YouTube that has since been scaled by Google across majorities of social media users in several European countries (Jigsaw, 2023), Roozenbeek, van der Linden, et al. (2022) showed that video-based inoculation interventions improved recognition of common techniques used to manipulate information—but few other field studies are available. Field studies that do exist have focused mainly on improvements in identifying manipulation, but none test behavioral measures such as the sharing of misinformation. However, one study did find clear evidence that inoculation reduced behavioral engagement with misinformation (e.g., liking, sharing) in a simulated social media setting (McPhedran et al., 2023).

In addition to their effect on misinformation, some (but not all) gamified inoculation interventions may slightly reduce the perceived reliability of more ambiguous "real news" items (Modirrousta-Galian et al., 2023), though a recent meta-analysis concluded that inoculation interven-

tions still improve truth discernment overall (Lu et al., 2023). Nonetheless, any intervention may engender a degree of skepticism about news and information in general, especially when the news is not obviously true. This general skepticism effect appears to be common for many kinds of misinformation interventions (Basol et al., 2021; Clayton et al., 2020; Green et al., 2022; Guess, Lerner, et al., 2020), but there is ongoing debate about its true prevalence. For instance, people do not appear to become more skeptical of news headlines that are obviously true (Modirrousta-Galian & Higham, 2023). It is also possible that the general skepticism effect is a methodological artifact of how efficacy studies are designed (akin to earlier concerns about backfire effects). Some studies show a significant effect of inoculation on the ability to distinguish misinformation from true information, but others do not—even though they use the same intervention and items (e.g., Basol et al., 2021; Roozenbeek, Maertens, et al., 2021; Roozenbeek & van der Linden, 2019). In addition, general skepticism can occur when the study contains more false than true stimuli (Altay, Lyons, & Modirrousta-Galian, 2023) or in control groups, likely as a function of repeated testing (Modirrousta-Galian & Higham, 2023).

There is also debate about whether the general skepticism effect is a good or a bad thing. On the one hand, it is probably undesirable to make people overly skeptical of all news, especially from trustworthy sources. On the other hand, reputable sources sometimes use manipulation, clickbait, or sensationalism when presenting news, so if people become slightly less certain that a (mostly) true headline is accurate if it is presented in a biased manner, the overall result may be healthy (rather than immutable) skepticism. Finally, research has found that undesirable skepticism can be counteracted by giving people feedback on their performance, which helps to consolidate learning (Leder et al., 2023).

CASE STUDY 4: *GO VIRAL*!

Go Viral! (https://goviralgame.com) is a free online game that inoculates people against COVID-19 misinformation. Funded by the Cabinet Office of the United Kingdom, the game teaches people about three methods used to manipulate information about COVID-19: emotional manipulation, fake expertise or pseudoscience, and conspiratorial reasoning. The game consists of 3 levels and takes approximately 5 minutes to complete (DROG Group & Cambridge Social Decision-Making Lab, 2020)

Go Viral! was used in efforts by WHO and the United Nations to combat health misinformation, and the campaign was seen by more than 214 million people worldwide (Government Communication Service International, 2021). After its launch, the game was the second most visited source of COVID-19 information on the WHO website.

In a study with ~3,500 participants, Basol et al. (2021) showed that playing the game significantly decreased the perceived reliability of COVID-19 misinformation, increased players' confidence in their ability to identify it, and decreased their willingness to share it with others. The study was conducted with versions of the game in three languages (English, French, and German), which compared favorably with infographics about COVID-19 misinformation created as part of UNESCO's #ThinkBeforeSharing campaign (2020). One week after completing the game, players remained significantly better than the control group at identifying manipulative content about COVID-19.

However, this campaign also had several important limitations. First, the researchers did not link the game to online or offline behavior, so it remains unknown whether players engaged less with vaccine misinformation or shared it less with others. The game also had no effect on intentions to obtain the COVID-19 vaccine, which implies that a separate set of interventions may be needed to combat vaccine hesitancy.

HEALTH, MEDIA, AND DIGITAL LITERACY INTERVENTIONS

The distinction between health literacy, media literacy, and digital literacy is increasingly blurred. *Health literacy* can generally be considered as the competencies required to find and evaluate health content for quality or accuracy (Norman & Skinner, 2006), *media literacy* focuses on the ability to evaluate print and online media messages (Potter, 2021), and *digital literacy* is defined as the skills required to execute tasks online (Reddy et al., 2022). Literacy interventions are often

provided as part of formal education or courses in the wider community (Nygren & Guath, 2021).

Efficacy of Literacy Interventions

Several meta-analyses have investigated health literacy interventions. For example, Nordheim et al. (2016) conducted a systematic review of school-based interventions to enhance adolescents' abilities to critically appraise health claims: The eight studies in their report generally found short-term benefits on knowledge and relevant skills. Moving outside the classroom, Nutbeam et al. (2018) conducted a review of studies on interventions to improve health literacy in community populations. They found only seven studies that met their inclusion criteria (out of an initial pool of 1117 papers), and they reported that the current interest surrounding health literacy was not matched by the number of systematic studies being conducted. They concluded that evidence supporting the implementation of national policies and programs was not emerging as quickly as needed. It is also possible that studies yielding nonsignificant findings remain unpublished (i.e., the "file drawer problem"; Rosenthal, 1979).

Regarding media literacy intervention studies, several meta-analyses have found them to be effective for improving media literacy skills (Vahedi et al., 2018), media knowledge, and critical perceptions towards media messaging or advertising (Jeong et al., 2012). However, when focusing specifically on the discernment of health misinformation, findings appear to be mixed. Badrinathan (2021) found that their 1-hour media literacy intervention in India did not lead to any improvements in the ability to discern health misinformation. Likewise, Vraga et al. (2021) found no effect of a news literacy video on protecting people against health misinformation. However, it is possible that the length of these interventions was too short. Bergsma and Carney (2008) found, in a meta-analysis of 28 health-promoting media literacy interventions, that long interventions (5 hours or more) were more likely to be effective than those that were short (< 60 minutes). In addition, some interventions may work best in conjunction with others. For instance, Hameleers (2020) found that media literacy paired with fact-checking was more effective than either intervention alone, in samples from both the United States and the Netherlands. An open question is whether media literacy interventions work best in children when they are first learning to evaluate information, rather than trying to correct bad habits after they have developed. However, most media literacy interventions to date have targeted high-school students or adults (e.g., Badrinathan, 2021; Wineburg et al., 2022).

Although digital literacy interventions have been studied much less than health-focused or media-focused efforts, promising research is emerging. For example, Guess, Lerner, et al. (2020) found that digital literacy training helped individuals distinguish between mainstream and false news in both the United States and among highly educated Indian participants. However, the researchers repeated their study in a rural community of northern India and found no effect, presumably because social media use was lower. Moore and Hancock (2022) found digital literacy training to improve news accuracy discernment in older adults. Further research has shown that it can improve online reasoning (McGrew et al., 2019; Nygren & Guath, 2021) and lateral reading on social media (Panizza et al., 2022).

Reviews and meta-analyses of health and media literacy interventions have long highlighted the lack of research on their efficacy over time. Bergsma and Carney (2008) found that there were beneficial short-term effects of health-promoting media literacy interventions, but none of the studies in their meta-analysis evaluated any long-term effects of interventions. Manafo and Wong (2012) also concluded that health literacy programs for older adults show promise, but long-term outcomes remain unknown. In the systematic review of school-based interventions described earlier by Nordheim et al. (2016), none of the eight studies investigated long-term effects. However, studies have recently begun to investigate these interventions with delayed retention intervals. Stassen et al. (2020) conducted a pre–post RCT on a web-based health literacy intervention and included a 6-month follow-up, but they found that their 8-week intervention did not increase health literacy when compared with a control group, either immediately or at follow-up. Digital literacy interventions by Guess, Lerner, et al. (2020) and McGrew et al. (2019) found effects that persisted after a 3-week period, but these improvements faded over time.

Limitations of Literacy Interventions

One limitation for health, media, and digital literacy interventions is that they are often quite lengthy and commonly require cooperation from schools, school districts, community centers, and/or local and national governments. Another potential limitation is cross-cultural applicability: Badrinathan (2021) and Guess, Lerner, et al. (2020) tested interventions on rural samples in India and found that their interventions were broadly ineffective. The largest problem with evaluating the efficacy of these interventions is that they vary widely in terms of content and duration, from a couple minutes to multiple weeks (Stassen et al., 2020). Finally, studies are difficult to compare because each one has different outcome measures (C. Smith

et al., 2021), so the field should consider establishing consensus on appropriate outcomes rather than using customized measures that vary from study to study (Nutbeam et al., 2018).

NUDGING

Thaler and Sunstein (2008) define *nudges* as "any aspect of the choice environment that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentive" (p. 6). Nudging interventions against misinformation are designed to positively influence people's behavior by, for example, prompting them to share less misinformation or low-quality content on social media. Major advantages of these interventions include that they are relatively easy to implement on social media (e.g., Twitter double-checks if users wish to retweet an article that they have not yet read) and that they do not require people to opt in to the intervention.

Several anti-misinformation nudges have been proposed, most notably accuracy nudges (Pennycook et al., 2020, 2021; Pretus et al., 2023), social-norms nudges (Gimpel et al., 2021), and motivational nudges (Rathje et al., 2023). *Accuracy nudges* involve making the concept of accuracy more salient in people's minds, which should then improve the quality of the content they share with others (Pennycook et al., 2021). For example, accuracy primes ask people to consider the accuracy of a single nonpolitical headline (Pennycook et al., 2020) so that they are thinking about accuracy as they move forward. *Social-norms nudges* (Roozenbeek et al., 2023) are geared toward news-sharing behavior and emphasize either injunctive norms (i.e., behaviors most people find acceptable or not) or descriptive norms about it (i.e., how other people respond in certain situations; Gimpel et al., 2021). *Motivational nudges* seek to motivate people to be as accurate as possible (e.g., paying them to correctly identify true and false news; Rathje et al., 2023). Other types of nudging interventions exist as well, such as importance primes (which promote sharing only accurate news) and asking people to pause to consider the accuracy of headlines (L. K. Fazio, 2020a). (See Epstein et al., 2021, for an overview.)

Efficacy of Nudging

Pennycook et al. (2020) found that a single accuracy nudge improved "sharing discernment," a measure of the quality of people's news-sharing decisions, for true versus false news headlines about COVID-19. A meta-analysis found that accuracy nudges were effective overall at improving sharing discernment, although this effect was both small and heterogeneous: In six of the 20 studies included, the main effect was not significant. The effect appeared to be stronger for more intensive interventions (e.g., multiple nudges shortly after one another) and weaker for a one-off accuracy nudge (Pennycook & Rand, 2022). A cross-cultural study in 16 countries showed that accuracy nudges improved the quality of people's sharing intentions in some but not all countries, with smaller or null effects in countries where people professed higher belief in misinformation (Arechar et al., 2023). Nonetheless, a field study on Twitter showed that a nudge to share information from higher-quality news sources (e.g., *The New York Times*, CNN) led to improvements in the quality of the sources people shared (Pennycook et al., 2021). There is also evidence supporting the effectiveness of social-norms nudges. Gimpel et al. (2021), for instance, found that highlighting the socially desirable behavior of reporting misinformation subsequently led to higher reporting rates. Motivational nudges (e.g., paying people to be as accurate as possible) significantly boosted discernment and reduced partisan bias in people's assessments of news headlines, mainly because people who were motivated to be accurate were more likely to identify true news stories that were incongruent with their political beliefs as correct (Rathje et al., 2023).

There is some ambiguity when it comes to the longevity of the nudging effect. In their field study, Pennycook et al. (2021) found that a single accuracy nudge was effective over a 24-hour period in improving the quality of news content shared. Roozenbeek, Freeman, and van der Linden (2021), on the other hand, found preliminary evidence for rapid decay, as the nudging effect in their study wore off after several headline evaluations. Twitter recently implemented a nudging feature that asks users to verify that they want to share an article they haven't read yet, but the efficacy (especially over time) of this intervention is not public knowledge. TikTok reported that showing an accuracy nudge at the start of videos containing unverified content reduced the sharing of such videos, although to this date no peer-reviewed study has been published (Gosnell et al., 2021).

Limitations of Nudging

Nudges appear to become less effective the more often people are exposed to them (Sasaki et al., 2021), but it is unclear whether this is the case for all types of nudges; more research is needed. Some people do not respond to nudges, especially when they do not want to be nudged, a concept known as "nudgeability" (de Ridder et al., 2021). In addition, the replica-

bility of accuracy nudge interventions appears to be somewhat mixed: Roozenbeek, Freeman, and van der Linden (2021) initially failed to replicate the aforementioned COVID-19 accuracy nudge study by Pennycook et al. (2020), but they found a minor effect after collecting additional data. Accuracy nudges had no effect on a sample of U.S. conservatives and Spanish far-right voters (Pretus et al., 2023), and several other papers have reported failed or mixed replications (e.g., Gavin et al., 2022). One explanation for this inconsistency is that nudges may work less well (or not at all) for especially persuasive misinformation or for people who generally rate misinformation as accurate (Arechar et al., 2023; Pennycook & Rand, 2022; Roozenbeek et al., 2023).

GENERAL LIMITATIONS OF MISINFORMATION INTERVENTIONS

Overall, research into misinformation interventions suffers from several general limitations. First, there is a lack of studies conducted in non-WEIRD (i.e., White, educated, industrialized, rich, and democratic) countries, particularly with samples of people who are not highly educated and/or live in rural areas (but see Badrinathan, 2021; Guess, Lerner, et al., 2020; Harjani et al., 2023; Iyengar et al., 2022). Second, more longitudinal studies need to be conducted to examine the efficacy of interventions over time, including when and whether booster shots should be administered to maintain effectiveness (Maertens et al., 2021). Third, field studies—especially ecologically valid ones that test interventions in naturalistic settings—are difficult and expensive to conduct (Roozenbeek & Zollo, 2022). Although more field research is being done (e.g., Mosleh et al., 2021; Pennycook et al., 2021; Porter & Wood, 2021; Roozenbeek, van der Linden, et al., 2022), improved access to social media platforms and data would make it much easier to test interventions in real-world environments (Pasquetto et al., 2020). Fourth, research conducted so far has focused almost exclusively on testing interventions in isolation, so our understanding of how well interventions work together—including whether they amplify or cancel each other—is limited. Simulated data suggest that combined interventions yield important cobenefits (Bak-Coleman et al., 2022), and a recent empirical study found that combining accuracy nudges with inoculation interventions can have positive synergistic effects on truth discernment (Pennycook et al., 2023). Finally, focusing on individual-level interventions (i.e., the "i-frame" or individual frame) may draw attention away from the need to develop system-level interventions (i.e., the "s-frame" or system frame; Chater & Loewenstein, 2022). Both types of interventions have advantages and disadvantages, and a comprehensive approach to tackling misinformation will inevitably incorporate elements of both.

Recommendations

RECOMMENDATION 1

Avoid repeating misinformation without including a correction.

The repetition of false claims increases belief in those claims, a phenomenon known as the illusory truth effect. People of all ages are susceptible to illusory truth, even when they already have relevant prior knowledge about the topic. When media sources, political elites, or celebrities repeat misinformation, their influence and repetition can perpetuate false beliefs. Repeating misinformation is necessary only when actively correcting a falsehood. In these cases, the falsehood should be repeated briefly, with the correction featured more prominently than the falsehood itself.

RECOMMENDATION 2

Collaborate with social media companies to understand and reduce the spread of harmful misinformation.

Most misinformation on social media is shared by very few users, even during public health emergencies. These "superspreaders" can play an outsized role in distributing misinformation. Social media "echo chambers" bind and isolate communities with similar beliefs, which aids the spread of falsehoods and impedes the spread of factual corrections. On social media, sensational, moral–emotional, and derogatory content about the "other side" can spread faster than neutral or positive content. Scientists, policymakers, and public health professionals should work with online platforms to understand and harness the incentive structures of social media to reduce the spread of dangerous misinformation.

RECOMMENDATION 3

Use misinformation correction strategies with tools already proven to promote healthy behaviors.

Psychological science research shows that the link between knowledge and behavior is imperfect. There is strong evidence that curbing misperceptions can change underlying health-related beliefs and attitudes, but it may not be sufficient to change real-world behavior and decision-making. Correcting misinformation with accurate health guidance is vital, but it must happen in concert with evidence-based strategies that promote healthy behaviors (e.g., counseling, skills training, incentives, social norms).

RECOMMENDATION 4

Leverage trusted sources to counter misinformation and provide accurate health information.

People believe and spread misinformation for many reasons: They may find it consistent with their social or political identity, they may fail to consider its accuracy, or they may find it entertaining or rewarding. These motivations are complex and often interrelated. Attempts to correct misinformation and reduce its spread are most successful when the information comes from trusted sources and representatives, including religious, political, and community leaders.

RECOMMENDATION 5

Debunk misinformation often and repeatedly using evidence-based methods.

Research shows that debunking misinformation is generally effective across ages and cultures. However, debunking doesn't always eliminate misperceptions completely. Corrections should feature prominently with the misinformation so that accurate information is properly stored and retrieved from memory. Debunking is most effective when it comes from trusted sources, provides sufficient detail about why the claim is false, and offers guidance on what is true instead. Because the effectiveness of debunking fades over time, it should be repeated through trusted channels and evidence-based methods.

RECOMMENDATION 6

Prebunk misinformation to inoculate susceptible audiences by building skills and resilience from an early age.

Instead of correcting misinformation after the fact, "prebunking" should be the first line of defense to build public resilience to misinformation in advance. Studies show that psychological inoculation interventions can help people identify individual examples of misinformation or the overarching techniques commonly used in misinformation campaigns. Prebunking can be scaled to reach millions on social media with short videos or messages, or it can be administered in the form of interactive tools involving games or quizzes. However, the effects of prebunking fade over time; regular "boosters" may be necessary to maintain resilience to misinformation, along with media and digital literacy training.

RECOMMENDATION 7

Demand data access and transparency from social media companies for scientific research on misinformation.

Efforts to quantify and understand misinformation on social media are hampered by lack of access to user data from social media companies. Misinformation interventions are rarely tested in real-world settings due to a similar lack of industry cooperation. Publicly available data offer a limited snapshot of exposure, but they cannot explain population and network effects. Researchers need access to the full inventory of social media posts across platforms, along with data revealing how algorithms shape what individual users see. Responsible data sharing could use frameworks currently in use to manage sensitive medical data. Policymakers and health authorities should encourage research partnerships and demand greater oversight and transparency from social media companies to curb the spread of misinformation.

RECOMMENDATION 8

Fund basic and translational research into the psychology of health misinformation, including effective ways to counter it.

Several interventions have been developed to counter health misinformation, but researchers have yet to compare their outcomes, either alone or in combination. There is a need to understand which interventions are effective for specific types of information: What works for one issue may not translate to others. Ideally, these questions would be answered by large-scale trials with representative target audiences in real-world settings. Increased funding opportunities for psychological science research are needed to address these important questions about digital life.

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