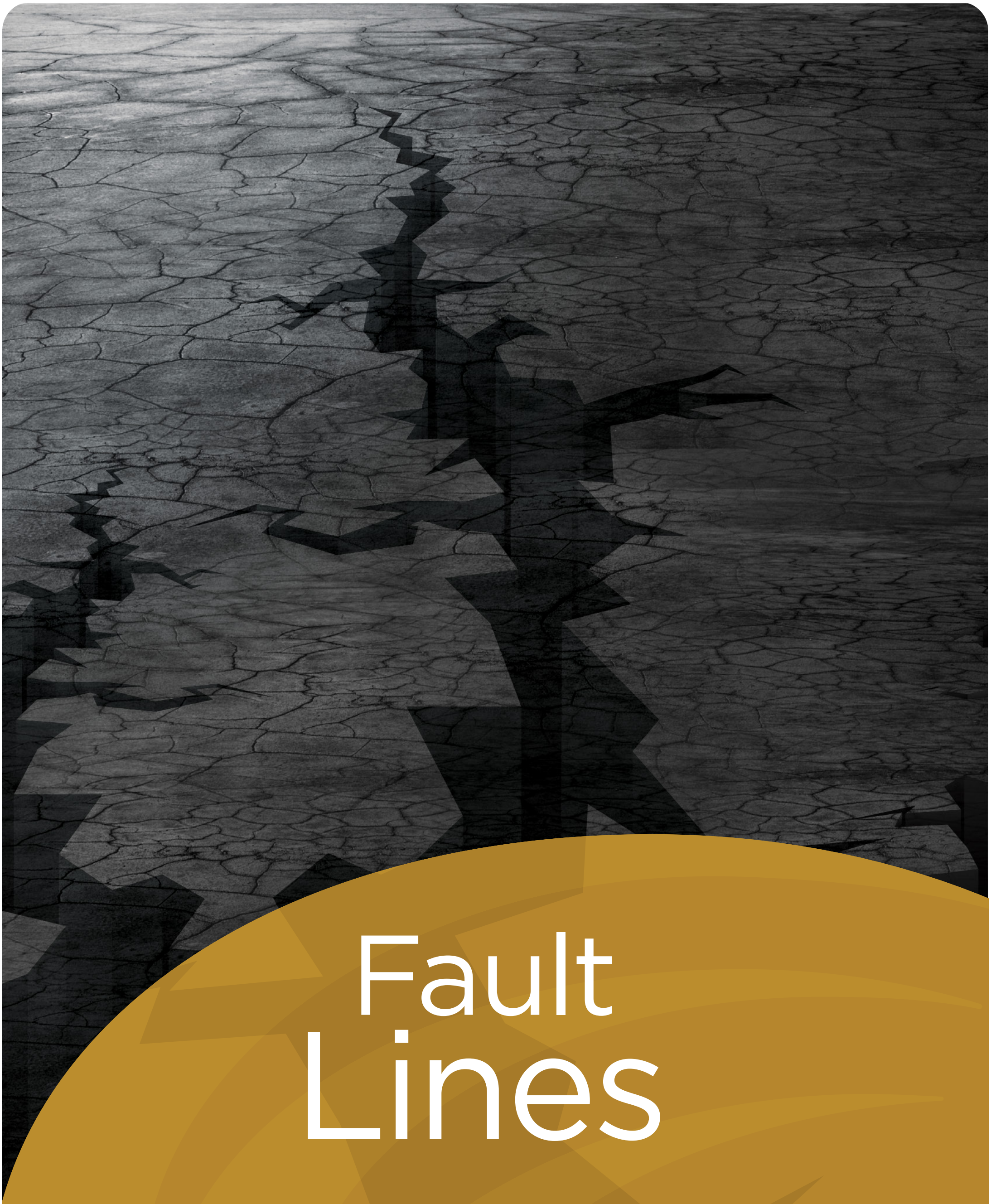

Fault Lines

Expert Panel on the Socioeconomic Impacts of Science and Health Misinformation

CCA | CAC

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of Science and Health Misinformation

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This project was undertaken with the approval of the Board of Directors of the Council of Canadian Academies (CCA). Board members are drawn from the Royal Society of Canada (RSC), the Canadian Academy of Engineering (CAE), and the Canadian Academy of Health Sciences (CAHS), as well as from the general public. The members of the expert panel responsible for the report were selected by the CCA for their special competencies and with regard for appropriate balance.

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The Expert Panel on the Socioeconomic Impacts of Science and Health Misinformation would like to acknowledge the Inuit, Métis, and First Nations peoples who have been stewards of the lands now known as Canada.

The Council of Canadian Academies (CCA) acknowledges that its Ottawa offices are located on the unceded, unsurrendered ancestral home of the Anishinaabe Algonquin Nation, who have cared for the environment of this territory for millennia.

Though our offices are in a single location, our work to support evidence-informed decision-making has potentially broad impacts across Canada.

We at the CCA recognize the importance of drawing on a wide range of knowledge and experiences to inform policies that will build a stronger and more equitable and just society.

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Expert Panel on the Socioeconomic Impacts of Science and Health Misinformation

Under the guidance of its Scientific Advisory Committee, Board of Directors, and founding Academies, the CCA assembled the **Expert Panel on the Socioeconomic Impacts of Science and Health Misinformation** to undertake this project. Each individual was selected for their expertise, experience, and demonstrated leadership in fields relevant to this project.

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Message from the President and CEO

An accepted definition of misinformation refers to claims that are either false or misleading and inadvertently shared (misinformation) or deliberately created or shared (disinformation). The impacts of misinformation in science and health are complex in their scope, scale, and severity. Of particular worry is that the dissemination of misinformation in science and health can, if left unchecked, undermine trust in society's use of science-based information to inform health decisions. A patient who believes misinformation may reject or unnecessarily fear proven medicines. When the public (or a sizable portion thereof) believes disinformation, they may oppose or decline interventions known to be safe and effective.

This was the context for the present report. The CCA assessment process is built to produce objective reports of the available evidence on a given subject, by bringing together leading thinkers and experts. It has not escaped our notice that a report on the impact of misinformation will itself be scrutinized. This is as it should be, and it is our hope that like all assessments, there will be widespread discussion of the panel's findings and their implications.

Fault Lines identifies the socioeconomic impacts of science and health misinformation on the public and public policy in Canada. The assessment of evidence is complemented by original modelling work commissioned to estimate the health impacts and hospitalization costs associated with COVID-19 vaccine hesitancy in Canada, and the role misinformation played in contributing to this hesitancy. Furthermore, the Panel examined leading practices for assessing and responding to misinformation.

This Expert Panel, chaired by Alex Himelfarb, had the additional challenge of undertaking this work almost entirely virtually. I would like to thank each member for the time, care, enthusiasm, and dedication they provided to this project. Thanks also to the CCA Board of Directors and Scientific Advisory Committee, and the founding Academies — the Royal Society of Canada, the Canadian Academy of Engineering, and the Canadian Academy of Health Sciences — for their guidance and oversight throughout the assessment process.

Eric M. Meslin, PhD, FRSC, FCAHS
President and CEO, Council of Canadian Academies

Message from the Chair

Misinformation is a defining issue of our times. It is, of course, not a new phenomenon. Myths, conspiracy theories, and deliberate deceit are probably as old as human communication. But the fact that Oxford Dictionaries named "post-truth" the word of the year in 2016 signals that something has changed. In this age of anxiety and distrust, we seem to be more vulnerable than ever to misinformation. Our information environment, transformed by social media, has facilitated and accelerated its transmission. Those intent on promoting misinformation for power or profit, or in furtherance of an ideology, have access to more and better tools than ever before. Little wonder that some have termed ours the post-truth era.

We face unprecedented and layered collective challenges: climate change, environmental degradation, pandemics, inequality, colonialism, racism, threats to democracy, war. How can we hope to begin to tackle these challenges, fix what's broken, and make things better if we can't even agree on what's happening? How can we determine where we are going if we can't agree on where we have been or even where we are?

While it's true that misinformation and deception are not new, we are arguably more vulnerable than ever to its consequences. The personal consequences are relatively easy to document: hospitalizations, deaths, and financial costs. The collective costs are more difficult to quantify but no less important to public health, the public purse, the social fabric, and the planet. We are none of us immune to misinformation and its consequences, though the most vulnerable, as always, bear the greatest costs.

While the explosion of misinformation didn't create the social cleavages that divide us, it's quite evident that it has deepened them, resulting in increased conflict and even violence. As misinformation has become entwined with identity and ideology, some politicians have amplified it to build their political coalitions. Misinformation and division are locked in a vicious cycle that needs to be broken.

Rebuilding trust, once lost or broken, is a difficult, long-term process, but a number of strategies have proven to be helpful. These include improving direct access to academic research; communicating research accurately and conveying uncertainty where it exists; and carefully selecting the messenger and the medium to reach diverse audiences most effectively. Many jurisdictions have developed innovative approaches to labeling and reducing on-line misinformation and to promoting greater media literacy. More fundamentally what's needed are policies that yield less inequality and more democracy, and a politics that seeks to heal our divisions rather than exploit them. Just as none of us is immune to misinformation and its impacts, all of us must be part of the solution.

Alex Himelfarb
Chair, Expert Panel on the Socioeconomic Impacts of Science and
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Peer Review

This report was reviewed in draft form by the individuals listed below — a group of reviewers selected by the Council of Canadian Academies (CCA) for their diverse perspectives and areas of expertise.

The reviewers assessed the objectivity and quality of the report. Their confidential submissions were considered in full by the Panel, and many of their suggestions were incorporated into the report. They were not asked to endorse the conclusions, nor did they see the final draft of the report before its release. Responsibility for the final content of this report rests entirely with the authoring Panel and the CCA.

The CCA wishes to thank the following experts for their review of this report:

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The peer-review process was monitored on behalf of the CCA's Board of Directors and Scientific Advisory Committee by **Peter Backx, FRSC,** Professor, Department of Biology, and Canada Research Chair in Cardiovascular Biology, York University. The role of the peer review monitor is to ensure that the Panel gives full and fair consideration to the submissions of the peer reviewers. The Board of the CCA authorizes public release of an expert panel report only after the peer review monitor confirms that the CCA's report review requirements have been satisfied. The CCA thanks Dr. Backx for his diligent contribution as peer review monitor.

Summary of Main Findings

Misinformation is an urgent societal concern that affects us all. It has also become a global concern. The World Health Organization and other bodies have recognized an *infodemic* running parallel to the COVID-19 pandemic; the Intergovernmental Panel on Climate Change has explicitly acknowledged the role politically endorsed misinformation plays in limiting climate action; and a new government agency in Sweden has been specifically tasked with identifying, analyzing, preventing, and countering misinformation. Worldwide, alarm over the impacts of misinformation on our lives is mounting.

Science and health misinformation exposes us to harms both personal and collective. On an individual level, it can leave us vulnerable to baseless fears, harm from preventable diseases, and exploitation by those who promote misinformation for profit or power. On a collective level, it erodes trust, fosters hate, undermines social cohesion, and diminishes our capacity for collective action. Catastrophic events, such as the COVID-19 pandemic and the droughts, floods, and wildfires exacerbated by climate change, underscore the need for reasoned, evidence-informed decision-making at both the personal and public level. Misinformation damages social cohesion and collective action by undermining democratic discourse and distorting our understanding of the potential consequences of both our personal choices and policy options.

Addressing misinformation is a complex, multidimensional, and inevitably controversial undertaking because it raises fundamental questions about how we communicate, build relationships, and understand the world, as well as questions about our personal values and identity. Given the importance of this issue, it is imperative that we invest in understanding the sources and consequences of misinformation, and the strategies being used to combat it and reduce its harmful impacts.

Recognizing misinformation's potential to create harm and undermine progress and public trust in scientific research, public health policy, and public institutions more generally (among other concerns), Innovation, Science and Economic Development Canada (ISED) put forward the following question and sub-questions for assessment:

What are the socioeconomic impacts of science and health misinformation[1] on the public and public policy in Canada?

- What are the impacts of misinformation on public trust in, engagement with, and understanding of science and science-informed policies?
- What characteristics of misinformation determine its influence? What factors determine an individual's interpretation of misinformation?
- What are leading practices for assessing and responding to the impacts of misinformation that are applicable to Canada?

To answer the charge, the CCA assembled a multidisciplinary panel of 13 experts (the Expert Panel on the Socioeconomic Impacts of Science and Health Misinformation, hereafter the Panel), which met 8 times over 14 months to review evidence and deliberate. The Panel's assessment was based on a review of diverse sources of evidence, including peer-reviewed publications, publicly available government information and statistics, media reports, and grey literature related to the impacts of, as well as strategies to combat, science and health misinformation within Canada and internationally.

Notably, this report was undertaken during the COVID-19 pandemic, when the study of science and health misinformation and its socioeconomic impacts was rapidly expanding. The Panel recognizes that this high volume of research has resulted in a dynamic and growing body of evidence, including non-peer-reviewed research, such as pre-prints and reports from advocacy organizations (these are identified as such when cited in this report). This evidence review is supplemented by original modelling work commissioned to estimate the health impacts and hospitalization costs associated with COVID-19 vaccine hesitancy in Canada, and the role misinformation played in contributing to this hesitancy. The report underwent a comprehensive peer review, whereby an additional 11 experts from Canada and abroad provided further evidence, feedback, and expertise.

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[1] The definition of misinformation adopted for this assessment, as proposed by ISED, includes both false or misleading information that is inadvertently shared (misinformation) and false or misleading information that is deliberately created or shared (disinformation).

The Socioeconomic Impacts of Misinformation in Canada

The impacts of science and health misinformation are manifold. They range in scope from individual or community effects to societal or global ones; they also range in severity, from relatively benign to deadly. Science and health misinformation undermines personal well-being when it drives us away from evidence-based medicine and toward unproven, costly, and potentially unsafe interventions. While isolating the specific impact of misinformation on any one decision (and its resultant harms) presents a formidable challenge, there is robust evidence supporting the contribution of science and health misinformation to the following individual and collective impacts (explored in Chapter 3):

- Illness, poisoning, and death from unsafe health interventions and products
- Illness and death from communicable and vaccine-preventable diseases
- Money wasted on disproven products and services
- Susceptibility to further and potentially more insidious forms of misinformation
- Increased healthcare and societal costs due to vaccine-preventable diseases
- Inaction or delayed public policy action

Misinformation contributes to a lack of adherence to public health measures and to vaccine hesitancy, which can result in vaccine-preventable disease outbreaks, increased healthcare costs, and elevated risk to the health and well-being of vulnerable populations. Misinformation also amplifies social divisions, which have resulted in overt conflict and violence, often directed at racialized communities. Furthermore, the consequences of science and health misinformation are not borne equally — for instance, negative health impacts during the COVID-19 pandemic have been found to impinge disproportionately on the well-being of racialized and other underserved communities, exacerbating existing inequalities.

The Cost of COVID-19 Misinformation in Canada

While there is ample evidence of misinformation contributing to higher rates of vaccine hesitancy and refusal during the COVID-19 pandemic in Canada, the socioeconomic impacts of this misinformation are less well understood. The complexity of the issues and major data gaps make it impossible to fully quantify the costs. As a partial remedy, the Panel commissioned[2] a quantitative economic model to provide an estimate of the direct healthcare costs of COVID-19 vaccine hesitancy (Chapter 4).

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[2] S. Ozawa led the modelling work under contract with the CCA while serving as a Panel member.

The model simulated the behaviour of people in Canada aged 12 and over between March 1 and November 30, 2021, tracking them through two waves of the COVID-19 pandemic. The model centred on whether people in Canada believed COVID-19 was a hoax and/or that vaccine harms have been covered up, drawing on the best available survey data. Consistent with the published evidence, it was assumed that these two streams of COVID-19 misinformation would contribute to vaccine hesitancy. The Panel then examined three hypothetical scenarios. The first scenario looked at what happens to COVID-19 vaccination rates and case numbers if the proportion of people who agreed with the statement "COVID-19 is a hoax and/or exaggerated" were vaccinated as soon as they became eligible. The second scenario looked at rates and case numbers if the proportion of people who agreed with the statement "vaccines cause many problems that are covered up" were vaccinated as soon as they became eligible. The third scenario modelled what would have occurred if everyone in Canada were vaccinated as soon as they became eligible. The baseline model used real-world Canadian data. To calculate the impact of misinformation, baseline model results were subtracted from the results of each hypothetical scenario in terms of the number of vaccinations, cases, hospitalizations, intensive care unit (ICU) visits, deaths, and hospitalization costs.

If those who reported believing COVID-19 is a hoax were vaccinated when they became eligible, over 2.3 million additional people in Canada would have been vaccinated, resulting in roughly 198,000 fewer cases, 13,000 fewer hospitalizations, and 2,800 fewer deaths from COVID-19 between March 1 and November 30, 2021. The cost of hospitalizations, including ICU visits associated with these cases, was conservatively estimated at $300 million. Estimates of the reductions in caseloads, hospitalizations, and deaths for all scenarios are reported in Chapter 4.

These modelled estimates of COVID-19 misinformation impacts in Canada are conservative because they do not capture other direct health costs, such as physician compensation, as well as the ripple effects across society, including the strain placed on Canada's healthcare system, opportunities for the creation of new variants, and slowing economic recovery. Moreover, while data limitations prevented inter-group comparisons, the Panel recognizes that impacts are experienced unevenly across society and among different groups, reinforcing longstanding inequities and divisions.

The Impacts of Misinformation on Public Trust and Engagement

Science and health misinformation is both a product of and contributor to the documented decline in trust, including trust in scientific, government, and healthcare workers and institutions. Misinformation also contributes to increasing polarization and social fragmentation. Declining trust, increasing polarization, and deeper social division provide the context in which misinformation is created and spread (Chapter 2), as well as the landscape on which its impacts are experienced (Chapter 3).

Misinformation undermines support for important public policies and trust in expert advice. For example, while the damage caused by misinformation about healthcare interventions is most visible and immediate when it negatively affects individual healthcare decision-making, there are also more insidious impacts on the erosion of trust and relationships among patients, healthcare providers, and the wider healthcare system. This trust is already fragile or severely eroded in some groups, especially those dealing with the effects of colonialism, systemic racism, or other forms of exclusion.

Science and health misinformation can lead to actions that divert public research funds and absorb scarce healthcare resources. For example, a polarized and aggressive misinformation environment discourages research and open discourse in some domains, particularly where harassment fuelled by misinformation harms people working in these domains. Misinformation during the COVID-19 pandemic resulted in documented incidents of arson, vandalism, stigmatization, and assault. Moreover, targeted misinformation campaigns have played a documented role in creating opposition to policies addressing climate change and the widespread and increasing human and economic damage it is causing. Similarly, misinformation about the safety of nuclear energy and genetically modified (GM) foods has stymied efforts to manage nuclear waste and improve global nutrition.

As science and health misinformation becomes intertwined with ideology and identity, it is also increasingly weaponized for political gain, feeding off and contributing to political polarization. Post-truth rhetoric — in which the very possibility of objective facts is contested — is common in totalitarian regimes but has now entered Canadian political discourse, contributing to the flourishing of misinformation, a reduced trust in our knowledge and democratic institutions, declining political participation, and an increasingly toxic and hostile communication environment.

The Characteristics and Influence of Misinformation

Science and health misinformation has become pervasive in our lives, but not all misinformation translates into belief or action. How content is communicated and circulated influences the likelihood of people believing and sharing a claim (Chapter 5). Our relative susceptibility to believing and spreading misinformation, and its impact on our subsequent actions, is variable. What is invariable is that everyone is, to some extent, vulnerable to misinformation regardless of age, education, socioeconomic status, psychology, or personality.

Misinformation may be crafted to take advantage of what science has taught us about human cognition. For example, we tend to believe messages that appeal to our emotions, and we more readily accept as fact messages heard repeatedly because they become increasingly familiar. Knowledge of our cognitive shortcuts and biases can be exploited to make misinformation messaging more persuasive. Messaging is more influential if it is repetitive and simple, provides a clear and unambiguous explanation for some event or circumstance, and appears to come from a trusted, credible source. Examples of how the impression of a credible source is evoked include:

- mimicking legitimate news formats and using similar-looking URLs;
- creating imposter social media accounts (e.g., for politicians, influencers, or celebrities);
- presenting credentials from disreputable or unaccredited institutions as legitimate;
- using credentials to comment outside the scope of one's education or expertise;
- using discredited, disreputable, or retracted scientific publications
- using trusted institutions, such as the court system, to validate messaging
- using pre-print servers and predatory publishers to promote misinformation;
- creating think tanks, non-governmental organizations, and institutes with names that evoke a specific value (e.g., Friends of Science, the Greening Earth Society), but which have an alternative agenda as documented by their funding sources (e.g., the fossil fuel industry).

Stories, often in the form of anecdotes, testimonials, and personal narratives, are particularly persuasive, as they appeal to our emotions and capture how we tend to process information; this can alter our perception of a source's trustworthiness, challenge our ability to detect factual errors, and ultimately increase our likelihood of accepting misinformation uncritically.

Misinformation can also be self-reinforcing. What we know, or believe we know, affects how we process new information. Misinformation that confirms our pre-existing beliefs reinforces our perception of its accuracy; when accepted as fact, it dampens our curiosity and reduces information-seeking behaviours. When we believe we are informed, we are less likely to seek out information on a topic than when we know we are uninformed. When we start to believe some misinformation, we become more susceptible to believing other misinformation.

Individual characteristics also influence how we perceive and interact with misinformation online. Some people, whether naturally or because of their training, are more predisposed than others to question their own intuitions and to reexamine their beliefs when presented with new evidence and are therefore less vulnerable to misinformation. Our political beliefs also play a role — studies from Canada and the United States have found that older adults and those with conservative political affiliations tend to encounter and share higher levels of misinformation.

Leading Practices for Addressing Misinformation

Addressing misinformation is a long-term challenge for which there is no single solution; however, a number of strategies and techniques for combatting misinformation across jurisdictions show promise.

Understanding the Sources and Spread of Misinformation

Science and health misinformation is produced and disseminated by a variety of sources and for various reasons; some sources are simply unaware or distrustful of the scientific consensus, while others actively seek to undermine trust. Whatever the intent, the proliferation of social media platforms has facilitated and accelerated the spread of misinformation, augmenting the ability for anyone to create and post content.

Social media and private messaging apps have become increasingly important platforms for the distribution of science and health misinformation. While social media companies are taking some steps to fight misinformation (Chapter 6), the economic incentives built into their websites and apps also drive its creation and spread. Social media companies primarily generate revenues by selling advertising space, the value of which is driven by users' engagement on the platform. Misinformation created to target audiences on social media can generate revenue for both the creators and the platforms themselves. Additional factors, such as the use of bots and recommendation algorithms on social media, have been shown to contribute to the creation and spread of misinformation online.

Strong and independent media is essential to having an informed public capable of holding our democratic institutions to account. At the same time, journalism, like social media, succeeds financially by capturing the attention of consumers. Professional journalists are expected to adhere to ethics guidelines that include standards and practices for ensuring accuracy and transparency in their reporting. Nonetheless, news media, competing for audience share, may oversimplify, misrepresent, and overdramatize scientific results, contributing to the spread of misinformation. The proliferation of news media options, such as talk radio, cable news, websites, and podcasts, allows for new business models and opportunities for science and health journalism, including those of questionable quality and uneven adherence to journalistic ethics and standards. Even among high-quality news sources, the demand for attention can bias science journalism toward sensationalism over substance.

Scientific and medical research is held to a high standard of research integrity by a variety of actors, including funders, regulators, academic institutions, and publishers. However, it is still performed by people, within systems and institutions, all of which are fallible. Misinformation can be the product of systemic failures in science and medicine, and in the communication of scientific knowledge and research findings. For example, scientific publications sometimes include findings that do not replicate, use weak methodologies, or include mistakes and errors. That is why no one study can be treated as definitive. Scientific consensus is built over time, with findings made public so studies can be scrutinized, the findings tested and retested, and explanations discarded when contradicted by the evidence.

While research misconduct is rare, slow action against fraudulent research can lend credibility to misinformation. More insidiously, scientists may respond to incentives in academic publishing and the funding system by spinning their research to appear more novel, ground-breaking, and relevant in their manuscripts and grant applications. Hype, bias, and research findings that are taken out of context may be further promoted by institutional press releases and spread by uncritical reporting. The potential for misinformation stemming from these sources is exacerbated by the fact that most people are not trained in science and interact with research findings through news media that is itself biased toward more sensational headlines. All of this is to say that how science is communicated is extremely important.

Responding to Misinformation

Strategies and techniques that improve trust, quality, and uptake of scientific information include:

- reliable, independent fact checking and clear labelling, such as using tags to indicate the presence of misinformation online;
- public education, including in media and science literacy and on the techniques used to spread misinformation; and
- improved access to academic research and more effective science communication, such as choosing appropriate media and messengers to deliver accurate and clear information.

Building and sustaining trust in knowledge institutions and health experts is central to addressing misinformation. Rebuilding trust, once lost or broken, is a difficult, long-term process, but a number of strategies have been shown to help, including improving access to academic research, communicating research accurately (as well as conveying uncertainty), and carefully selecting the messengers and the medium to most effectively reach diverse audiences.

Just as none of us is immune to misinformation and its impacts, all of us must be part of the solution. Empowering people to confront misinformation when they encounter it, be it among friends and family, or in their professional lives, can leverage pre-existing relationships and help limit spread. Tailored and culturally sensitive strategies are needed for diverse communities. Such outreach has been shown to increase access to accurate medical information and counter misinformation.

We are also seeing increasing action at national and international levels. Many countries have negotiated cooperation agreements with each other — and with online media companies — to combat misinformation. While regulation of the online environment is sensitive and controversial, as it must address the tensions between free expression and social harm, a number of states have introduced or are working on regulations in this area. Chapter 6 details what is being tried and what seems to be working to combat misinformation.

Final Thoughts

However difficult to quantify, there is clear evidence that misinformation causes substantial harms at the individual, community, and societal levels. It feeds off and amplifies pre-existing divisions and inequities, with harms falling most heavily on the most vulnerable. In times of crisis or emergency, our vulnerability to misinformation is heightened, as are its consequences. We have strategies and tools to help combat these harms, strengthen and build trust in our institutions, and boost our ability to recognize and reject the misinformation we encounter.

We are all susceptible to misinformation and vulnerable to its harms, both personally and collectively. The task of confronting misinformation and mitigating its impacts can feel overwhelming and impossible, but we are not in a position to turn away. The future health and well-being of people in Canada, and around the world, depend on our recognizing and responding to science and health misinformation today.

The Importance of Striving for Objectivity and the Risks of Studying Contentious Subjects

Researching and critiquing misinformation will inevitably draw fire. Any study or report that takes it on is itself likely to become the target of misinformation, particularly by those who profit from its spread (Corn, 2012; Nogrady, 2021). For example, those who work in contentious fields are often accused of being part of a larger conspiracy, pursuing personal gain, or representing a homogenous and biased perspective. The CCA's process, like the scientific process more generally, endeavours to safeguard against these problems by using the best available evidence, requiring peer review and fact checking, and ensuring data transparency, accuracy, and independence.

Misinformation in various forms, such as fearmongering, personal attacks, conspiracy theories, outright lies, or attacks on patriotism, attempt to discredit and silence journalists, public health officials, doctors, and scientists (Tong *et al.*, 2020; Miller, 2021). Similar tactics may be used to attempt to smear studies of misinformation. Terms such as "fake news" are used to rob words of meaning and discredit the messenger and therefore the message (Habgood-Coote, 2018; Ross & Rivers, 2018; Tong *et al.*, 2020). Differences in the interpretation of data are expected as part of the scientific process, but in a way that is materially different from, for example, selectively using studies or overemphasizing uncertainty to sow doubt.

Attempts to address misinformation are often characterized as censorship. The Panel does not endorse solutions to misinformation that violate freedom of expression as protected by the *Canadian Charter of Rights and Freedoms*. In fact, a fundamental norm of the scientific endeavour is that the work of science must be transparent and shared so it can be tested and scrutinized. The Panel acknowledges the enormity of the challenges of addressing misinformation and believes it is surmountable through committed and considerable collective will.

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1

Introduction

1.1 The Charge
1.2 What Is Misinformation?
1.3 Why Misinformation Matters
1.4 The Panel’s Approach

Misinformation is a growing global concern. The World Health Organization (WHO) and other bodies have recognized an infodemic running parallel to the COVID-19 pandemic (WHO *et al.*, 2020); the Intergovernmental Panel on Climate Change (IPCC) has explicitly acknowledged the role politically endorsed misinformation plays in limiting climate action (IPCC, 2022); and a new government agency in Sweden has been specifically tasked with identifying, analyzing, preventing, and countering misinformation (Psychological Defence Agency, 2022). Alarm is mounting over the impacts of misinformation on the lives of people worldwide.

Science and health misinformation exposes us to harms both personal and collective. We have all encountered seemingly benign science and health misinformation, be it family lore about the best way to treat a cold, or urban legends about alligators living in the sewers of New York. However, science and health misinformation also makes us vulnerable to harm from preventable diseases, con artists, and divisive or hateful ideas. Catastrophic events, such as the COVID-19 pandemic and the droughts, floods, and wildfires exacerbated by climate change, highlight the need for reasoned, evidence-informed decision-making at both the personal and public levels. Misinformation damages social cohesion and collective action by undermining democratic discourse and distorting our understanding of the potential consequences of both personal choices and policy options.

Addressing misinformation is a complex, multidimensional, and controversial task because it raises fundamental questions about how we communicate, build relationships, and understand the world, as well as questions about our personal values and identity. Though addressing misinformation is of urgent societal concern, understanding its role in decision-making is inevitably contentious. This is because the line between information and misinformation can shift and blur as we learn more about the world, and because the link between information and decision-making is mediated by social and cultural factors, by personal and community experiences, and by the level of trust we have in each other and our institutions. Yet, given the stakes, we cannot afford to ignore misinformation’s impact on the lives of people and public policy in Canada.

1.1 The Charge

Recognizing misinformation's potential to create harm, stymy progress, undermine public trust in scientific research and public policy, and threaten human health and well-being more generally, Innovation, Science and Economic Development Canada (ISED) put forward the following question and sub-questions for assessment:

What are the socioeconomic impacts of science and health misinformation[1] on the public and public policy in Canada?

- What are the impacts of misinformation on public trust in, engagement with, and understanding of science and science-informed policies?
- What characteristics of misinformation determine its influence? What factors determine an individual's interpretation of misinformation?
- What are leading practices for assessing and responding to the impacts of misinformation that are applicable to Canada?

1.2 What Is Misinformation?

Information imparts knowledge — that is, awareness of people, facts, and things that have occurred, exist, or are believed or claimed to be true (Barber *et al.*, 2006). From the perspective of the receiver, misinformation is "any piece of information that is initially processed as valid but that is subsequently retracted or corrected" (Lewandowsky *et al.*, 2012a). Information and misinformation are distinguished, respectively, by their alignment with or against the evidence and the experts (Vraga & Bode, 2020).

The distinction between information and misinformation can be contentious and shift

One might consider the publication of research findings in a scientific journal a source of verifiable and reliable information; however, scientific knowledge changes as evidence accumulates, building over time through replication and revision (Ritchie, 2020). Some claims, represented as information initially, become misinformation as new knowledge emerges to discredit earlier understanding (Lewandowsky *et al.*, 2012a). A small proportion of claims reported in scientific journals are falsely made; cases of fraud, while rare, can also influence the circulation of misinformation (Ritchie, 2020). Scientific understanding will shift over time and among different communities, particularly when the phenomenon being studied is complex, novel, or evolving. Some uncertainty over what is understood to be information and misinformation is expected, particularly as evidence and expertise emerge in new and developing domains (Vraga & Bode, 2020).

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[1] Misinformation includes false or misleading information that is inadvertently shared (misinformation), as well as false or misleading information that is deliberately created or shared (disinformation).

For example, there was substantial uncertainty among people in Canada regarding the effectiveness of using face masks as a protective measure early in the COVID-19 pandemic (Zhang *et al.*, 2021a). This was driven in part by the limited amount of evidence and inconsistent public health messaging, including over the mode of viral transmission (Zhang *et al.*, 2021a; Lewis, 2022). However, disagreement over the effectiveness of face masks persisted even after evidence accumulated and a consensus on their public health benefits emerged (Lewis, 2022). As evidence for masks' effectiveness in controlling viral spread was scrutinized, verified, and — ultimately — widely accepted among scientific and medical experts (e.g., Brooks & Butler, 2021; CDC, 2021; Howard *et al.*, 2021), ongoing claims that mask wearing is ineffective or even harmful have shifted firmly into the realm of misinformation.

Misinformation includes different types of false claims and intentions

A variety of terms are used to categorize different types of misinformation, which vary along a gradient of information quality, as well as by the messenger's intention and the purpose of the claims (Figure 1.1). For example, Hendricks and Vestergaard (2019) describe a scale of information quality that moves from true statements (verified facts), through distortion (framing, exaggeration, selective use of evidence) and rumour (maybe true, maybe false), to outright falsehoods (lies, fake news). In practice, misinformation can include statements that fall anywhere along this scale, from verifiable facts to false claims, and often includes a mixture of information quality (Hendricks & Vestergaard, 2019). For example, some misinformation may be propaganda, but propaganda is not always misinformation. Propaganda is characterized by its purpose, which Stanley (2015) identifies as political rhetoric that exploits and strengthens flawed ideologies. As propaganda is neither false nor insincere by default, one cannot consistently characterize all propaganda as misinformation (Stanley, 2015). Still, science and health misinformation is used as propaganda when it is wielded as a tool for furthering political interest and promoting flawed ideologies (explored further in Section 2.2).

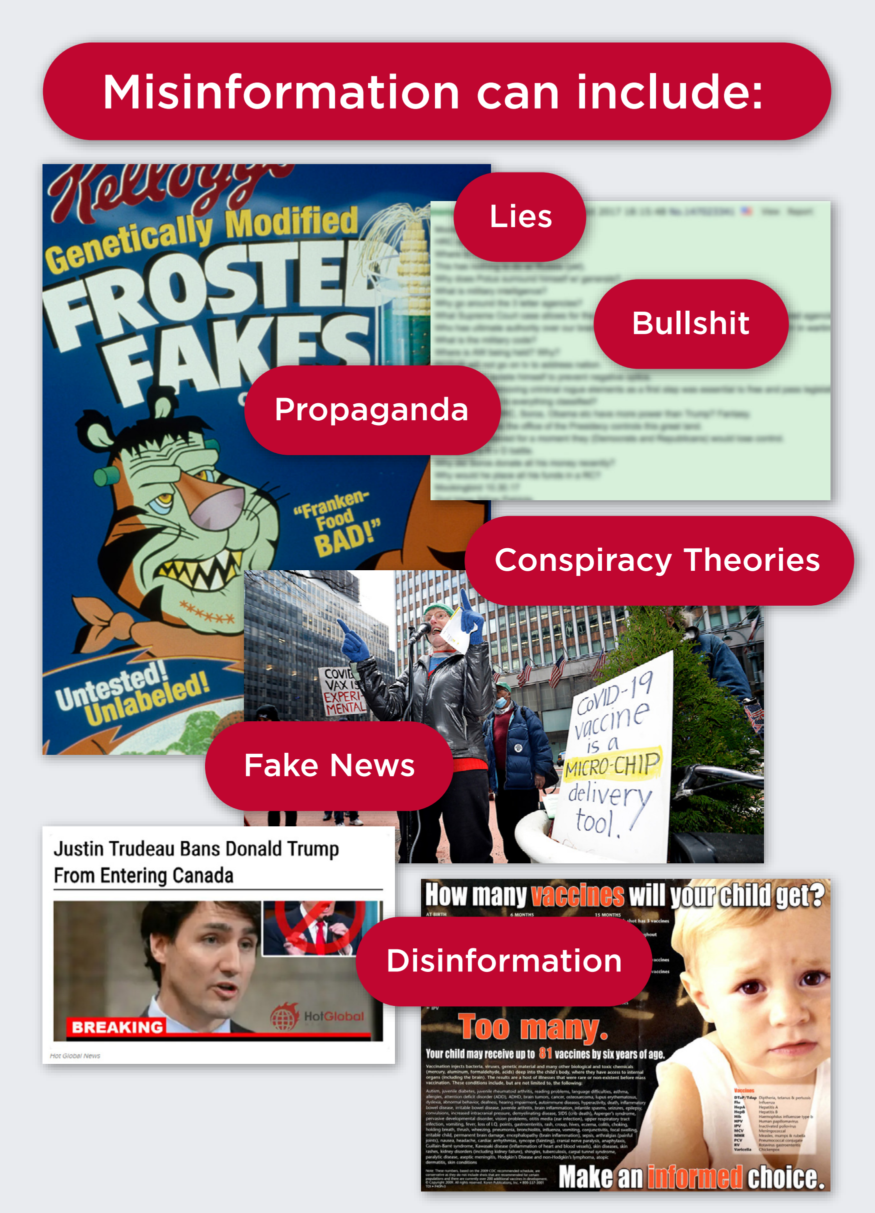
Misinformation can include:
Lies
Bullshit
Propaganda
Conspiracy Theories
Fake News
Disinformation
Kellogg's
Genetically Modified
FROSTED FAKES
"Franken-Food BAD!"
Untested! Unlabeled!
COVID VAX IS EXPERIMENTAL
COVID-19 vaccine is a MICRO-CHIP delivery tool.
Justin Trudeau Bans Donald Trump From Entering Canada
BREAKING
HotGlobal
Hot Global News
How many vaccines will your child get?
Too many.
Your child may receive up to 81 vaccines by six years of age.
Make an informed choice.

Figure 1.1 Different Types of Misinformation

For the purposes of this report, *misinformation* is used as an umbrella term to capture different types of false or misleading claims that are created and shared for a variety of purposes, including personal, political, social, and commercial gain. The images above were collected as examples of misinformation found online.

Similarly, while conspiracy theories may not always be entirely false, they can be a type of misinformation of particular interest to researchers because of the purpose of their claims, which is to "explain some event or practice by referring to the secret machinations of powerful people who have also managed to conceal their role" (Sunstein, 2014). Conspiracy theories provide something, or someone, to blame (Sunstein, 2014). Research on conspiracy theories is relevant to broader discussions of misinformation, since conspiracy theories can be markedly difficult to counteract; those who believe them distrust the knowledge-producing institutions that could provide credible information to dispel these beliefs, and they may even view the lack of evidence as proof of a cover-up (Sunstein, 2014). Conspiracy theories are frequently invoked in science and health misinformation. Examples include denying the link between HIV and AIDS, accusations of cover-ups of vaccine harms, and claims of organized corruption in climate change research (Kalichman, 2009; Briones *et al.*, 2012; Lewandowsky *et al.*, 2012b). Lewandowsky (2021) argues the role of conspiracy theories is particularly substantial in science and health misinformation because believers must either refute an overwhelming scientific consensus built on facts or presume that researchers are deliberately and collectively hiding the truth.

Misinformation is shared for a variety of reasons

The messenger's intention plays an important role in characterizing different types of misinformation, though it is difficult to know a person's intention with any certainty. For example, lying describes a situation where the person knows (or believes they know) the truth and deliberately avoids it (Frankfurt, 2005). In contrast, "bullshit" has become a term of art used to describe statements made by an individual unconcerned about, and unaware of, the relationship between their own words and verifiable facts; they do not know, nor do they care, whether the claims they make are true or false. Frankfurt (2005) describes how someone engaging in an informal bull session — for example, trading stories or political opinions over drinks — can use it as an opportunity to assess reactions and try out different ideas, with the collective understanding among participants that true beliefs or feelings are not being revealed. Bullshitting on online message boards likely accounts for at least some (if not most) of the early false conspiracy theories created by QAnon and held as truth by its adherents (e.g., Reply All, 2020). While bullshit is a constant presence in the information environment, empirical research examining this phenomenon has only recently emerged (e.g., Pennycook *et al.*, 2015; Littrell *et al.*, 2021).

Disinformation describes a "coordinated or deliberate effort to knowingly circulate misinformation in order to gain money, power, or reputation" (Swire-Thompson & Lazer, 2020). In cases of known disinformation, intention is relatively easy to infer — sometimes it is even readily apparent. For example, fake news[2] is misinformation designed to look like traditional media sources (Gelfert, 2018). The creators of fake news stories want them to go viral in order to maximize reach and advertising revenues; content is therefore drafted to garner engagement and shares irrespective of the truth (Alba-Juez & Mackenzie, 2019; Pennycook & Rand, 2020). Another example is shock and chaos misinformation, disinformation weaponized to "secure the allegiance of followers and to root out and suppress potential dissidents" (McCright & Dunlap, 2017). It involves a multitude of claims that are sometimes incoherent (e.g., spreading messages that support opposing positions), and its goal is not to get people to believe any one claim but to undermine the very notion that truth is discernible (Lewandowsky, 2021).

Characterizing different forms of misinformation is valuable in the study of these phenomena, particularly when it comes to finding ways to counter their spread and mitigate their impacts. However, for the purposes of this report, the Panel uses the umbrella term "misinformation" for its many forms described above, unless it is speaking directly to evidence relevant to a specific type (e.g., conspiracy theory, fake news).

1.3 Why Misinformation Matters

We are all susceptible to misinformation. People make decisions based on information at hand, but not always in a careful or thoughtful way. We use heuristics (i.e., mental shortcuts) influenced by internal biases to make quick judgments and avoid cognitive strain in normal situations (Tversky & Kahneman, 1974; Kahneman, 2013). As our understanding of biases and heuristics has grown, so too has our ability to exploit them. Misinformation in science and health can take advantage of our "predisposition to have strong, intuitive reactions to scientific advances, while having little knowledge base to accurately distinguish facts from falsehoods" (Merkley & Loewen, 2021). We find misinformation that is simple, emotionally engaging, appears credible, and that fills gaps in our current understanding to be especially persuasive (see Chapter 5). Moreover, the more misinformed we are — that is, the more inaccurate our beliefs about facts — the harder it is for us to correct those inaccurate beliefs; a *misinformed* person is more likely to believe they are informed, whereas a person who is *uninformed* is usually aware of their lack of knowledge (Kuklinski *et al.*, 2000; Nyhan, 2010).

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[2] While not a new phenomenon, the labelling of accurate information as "fake news" has become a means of discrediting or slandering the story. As such, use of the term is largely avoided in this report.

Throughout history, societal crises have been associated with some forms of misinformation, often conspiracy theories (van Prooijen & Douglas, 2017; Freckelton, 2020). Crises such as the COVID-19 pandemic, environmental disasters, and armed conflict (domestic or foreign) all contribute to feelings of anxiety, uncertainty, and loss of control, which are linked to our susceptibility to conspiracy ideation (reviewed in van Prooijen & Douglas, 2017). In early 2021, 16% of people in Canada believed that both the reported number of COVID-19-related deaths and the severity of the pandemic were exaggerated (EKOS, 2021). Those who were misinformed about COVID-19[3] also reported lower support for action in other policy areas where misinformation can hold influence, including climate change, addressing systemic racism, and advancing reconciliation with Indigenous Peoples (EKOS, 2021). Most people in Canada agree that fake news is negatively influencing political discussions with family and friends (CIGI & Ipsos, 2019). The Aspen Institute's Commission on Information Disorder (2021) argues that "information disorder is a crisis that exacerbates all other crises. When bad information becomes as prevalent, persuasive, and persistent as good information, it creates a chain reaction of harm."

Stressful situations can increase our vulnerability to misinformation. For example, Guidry *et al.* (2022) found higher endorsement of COVID-19 misinformation among people who were actively being treated for cancer when compared to those who either did not have cancer or who had successfully completed treatment. The authors theorize that anxiety about the pandemic's influence on their treatment may drive some people to seek more information on websites and social media, leading to higher levels of exposure to misinformation (Guidry *et al.*, 2022).

Our media landscape includes a proliferation of platforms that are produced and shared around the world and available at our fingertips, on demand, including talk radio, television, websites, podcasts, and social media. This continually expanding information environment has made it easier for misinformation to spread at an unprecedented speed and scale (Baker, 2020; Murthy, 2021). As Bufacchi (2021) notes, "today we live in a world where there is total deregulation on both the formation of, and access to, information." Science and health misinformation threaten the collective well-being of people in Canada and around the world. As West and Bergstrom (2021) assert, "we cannot solve problems of public health, social inequity, or climate change without also addressing the growing problem of misinformation." Nor, the Expert Panel notes, will we curb misinformation without attention to health and social inequities.

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[3] Defined in these survey results as people who agreed that the reported number of COVID-19 deaths and severity of the pandemic have been exaggerated, that masks do very little to prevent the spread of COVID-19, and that COVID-19 was manufactured in a lab (EKOS, 2021).

1.4 The Panel's Approach

To answer the charge, the CCA assembled a multidisciplinary panel of 13 experts (the Expert Panel on the Socioeconomic Impacts of Science and Health Misinformation, hereafter the Panel). Panel members had expertise in public policy, science culture, science communication, economics, and human behaviour and cognition, as well as experience as healthcare practitioners. Over the course of the assessment, the Panel met eight times to review evidence and deliberate on its charge. Each member volunteered on the Panel as an individual rather than as a representative of a specific discipline, organization, region, or set of values. At the beginning of the assessment process, the Panel met with ISED to acquire a full understanding of the charge. At this meeting, the Panel confirmed that the primary focus of the assessment was to be on the socioeconomic impacts of science and health misinformation in Canada, particularly as it relates to public health, climate change, resource management, emerging technologies, and trust.

The Panel notes that misinformation proliferates across a variety of platforms, driven by many different intentions and actors, and influenced by institutional biases and social forces that contribute more or less diffusely across a dynamic and shifting information landscape. As such, misinformation is only one contributing factor in our individual and collective decision-making. Regardless, a democratic society cannot ignore the impacts of misinformation, whether blatant and immediate or insidious and more difficult to pin down. Thus, the Panel has broadly examined the nature and impacts of science and health misinformation in three areas where there is robust evidence:

- Vaccine hesitancy
- Health and wellness (e.g., nutrition, genetically modified (GM) food products, alternative medicine)
- Acceptance of climate change (as well as desire and actions to combat it)

These three focal areas are explored and revisited throughout the report to examine how misinformation is disseminated and assimilated, how it influences decision-making, and to assess its personal, social, and economic impacts in Canada.

1.4.1 Evidence

The Panel's assessment was based on a review of diverse sources of evidence, including peer-reviewed publications, publicly available government information and statistics, media reports, and grey literature[4] related to the impacts of, as well as strategies to counter, science and health misinformation within Canada and internationally. This report is based on a detailed analysis of key references that the Panel felt represented the best available evidence on the topics discussed. Notably, the report was developed during the COVID-19 pandemic, when the study of science and health misinformation and its socioeconomic impacts was rapidly expanding. The Panel recognizes that this high volume of research has resulted in a dynamic and growing body of evidence, including non-peer-reviewed research such as pre-prints and reports from advocacy organizations, which are identified as such when cited in the report.

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[4] *Grey literature* refers to various types of documents produced by government, academia, industry, and other organizations that are not published commercially or formally.

The Panel's evidence review was supplemented by original modelling work[5] undertaken to estimate the health impacts and hospitalization costs associated with COVID-19 vaccine hesitancy in Canada, focusing on the contribution of misinformation to this hesitancy. The model simulated the behaviour of people in Canada aged 12 and over between March 1 and November 30, 2021, tracking them through two waves of the COVID-19 pandemic. The model centred on whether people in Canada believed COVID-19 was a hoax, and drew on the best available survey data. Consistent with the literature on vaccine hesitancy, the model assumed that believing COVID-19 to be a hoax contributes to vaccine hesitancy.

The Panel's model examined three hypothetical scenarios. The first scenario looked at what happens to COVID-19 vaccination rates and case numbers if the proportion of people who agreed with the statement "COVID-19 is a hoax and/or exaggerated" were vaccinated as soon as they became eligible. The second scenario examined misinformation about vaccine safety by including, among vaccinated people in Canada, the proportion of those who agreed with the statement that "vaccines cause many problems that are covered up." The third scenario modelled what would have occurred if all people in Canada were vaccinated as soon as they were eligible. The baseline model used real-world Canadian data. To calculate the impact of misinformation, baseline model results were subtracted from the results of each hypothetical scenario in terms of number of vaccinations, cases, hospitalizations, intensive care unit (ICU) visits, deaths, and hospitalization costs.

A draft of the report underwent a comprehensive peer review, whereby an additional 11 experts from Canada and abroad provided further evidence and expertise.

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[5] S. Ozawa led the modelling work under contract with the CCA while serving as a Panel member.

1.4.2 Report Structure

The Panel developed a narrative structure to guide its examination of the socioeconomic impacts of science and health misinformation on the public and on public policy in Canada. **Chapter 2** provides an overview of the context in which science and health misinformation proliferates, including social trends and recent transformations in the information and communication environment. **Chapter 3** reviews evidence documenting the impacts of misinformation on individuals, communities, and society in Canada and around the world. **Chapter 4** presents the model of the impact of COVID-19 misinformation on vaccination rates in Canada, producing quantitative estimates of impacts on our health (numbers of infection, hospitalization, and death) and the economy (hospitalization costs), and situating these within a broader context of societal and economic harms. **Chapter 5** looks at the evidence on communication strategies, what makes us susceptible to misinformation messaging, and how we might use these insights to improve societal resilience. **Chapter 6** follows with an examination of promising practices to combat misinformation through policy, education, and trust building at different levels of intervention. In **Chapter 7**, the Panel summarizes its key takeaways and provides final reflections on the charge.

2

Where Misinformation Comes From

2.1 Creation and Spread

2.2 Societal Factors

Chapter Findings

- The information environment has expanded substantially; anyone with an internet connection can create, post, and share content through social media, private messaging apps, podcasts, and websites, with or without an editor, standards, or guidelines.
- Science and health misinformation has been used to further commercial, political, and ideological interests; while social media is a clear target for manipulation, traditional media is not immune.
- Journalism, science, and health institutions have processes in place to ensure accuracy and rigour in communication; however, weak communication, uneven access, perverse incentives, and failures within these institutions can contribute to the creation and spread of misinformation.
- Science and health misinformation can be both a cause and consequence of societal trends toward lower institutional trust, increasing partisan polarization, and an undermining of the legitimacy of our scientific, healthcare, and democratic institutions.

The proliferation of communication platforms coupled with the economic incentives of engagement on the internet, among other factors, drives the production and spread of harmful science and health misinformation. Kahan (2017) argues that the public conflict over decision-relevant science is "a recognition problem, not a comprehension problem;" that is, it has become increasingly difficult to identify legitimate and trustworthy information sources. This misinformation can damage our personal and community well-being through otherwise preventable illnesses, deaths, and economic losses, and it can damage our social and societal well-being through polarization and the erosion of public trust and social cohesion. These impacts are differentially experienced among communities in Canada, and the impacts themselves can be both cause and consequence of a decline in institutional trust, increased partisan polarization, and the undermining of scientific and institutional legitimacy. Before discussing specific socioeconomic impacts of misinformation (Chapters 3 and 4), the Panel examines the informational and societal context in which misinformation is created, spread, and experienced.

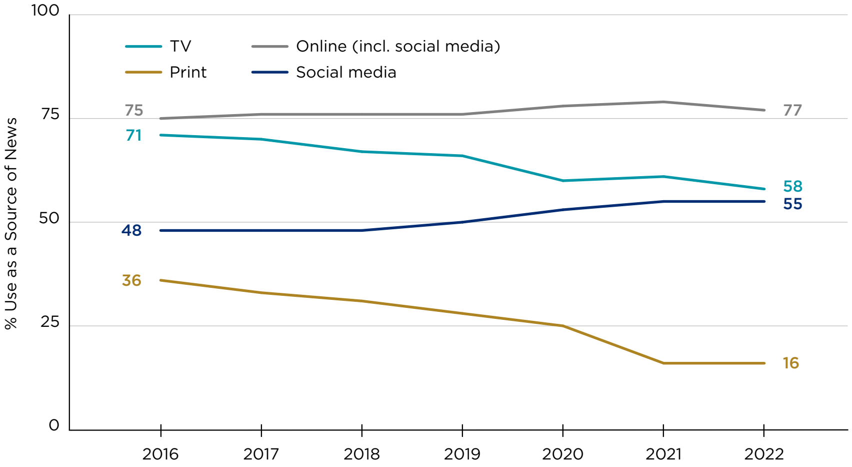
2.1 Creation and Spread

Science and health misinformation is pervasive in the information environment — it is produced and disseminated by a variety of sources, ranging from those actively seeking to undermine trust to those oblivious to the evidence base. It can even stem from errors or overstatements made by the very institutions we expect to provide high-quality information. The proliferation of social media platforms has augmented the ability for anyone to create and post content, contributing to the onslaught of misinformation we are increasingly exposed to in Canada and around the world. While social and news media companies, governments, and other actors have taken steps to combat misinformation and promote high-quality information (see Chapter 6), factors related to the creation and spread of misinformation in these areas are explored below.

2.1.1 Social Media

The impact of social media on the information environment has been transformational. As of 2021, the internet reached 93% of Canada's population of 38 million (Internet World Stats, 2021). Of adults in Canada who use the internet, 83% have a Facebook account, 65% use a private messaging app (e.g., WhatsApp, Facebook Messenger), and 64% have a YouTube account (Gruzd & Mai, 2020a). This increase in social media use has occurred rapidly. Facebook was created in 2005; by 2007, it was gaining over a million new users worldwide each week (Edosomwan *et al.*, 2011). People in Canada are moving away from print and television as their main sources of news and are instead turning to online platforms to stay informed (Newman *et al.*, 2022). In an online questionnaire representative of the population in Canada, 77% of respondents stated they source their news online, including 55% who get their news from social media; only 16% source their news from traditional print media (Newman *et al.*, 2022). Facebook and YouTube were the top social media platforms used as news sources, by 40% and 32% of respondents, respectively (Newman *et al.*, 2022).

The kinds of social media platforms used by people in Canada are also changing. For example, in 2017, messaging apps were not included as part of a national survey of social media use in Canada but, by 2020, they represented the second-highest user base (Gruzd & Mai, 2020a). Other additions to the social media landscape between 2017 and 2020 include TikTok (15% of adults who are online in Canada have a TikTok account), Twitch (9%), and WeChat (7%) (Gruzd & Mai, 2020a). As more of us find our news online, fewer of us access news through television and print media (Figure 2.1). Even the devices we use to access the news have changed, with 61% of respondents using a mobile device to read the news in 2022, up from 39% in 2016 (Newman *et al.*, 2022).



Adapted with permission from Newman *et al.* (2022)

Figure 2.1 Sources of News in Canada, 2016 to 2022

While many people in Canada still watch the news on television, most find at least some of their news online, with a growing proportion of that access coming through social media platforms.

Social media sites and messaging apps are used to spread misinformation

Social media use is correlated with a person's likelihood of believing and accepting health-related misinformation and conspiracy theories (Featherstone *et al.*, 2019; Jennings *et al.*, 2021). The extent to which a person gets their information from social media also predicts their susceptibility to misinformation about COVID-19 (Roozenbeek *et al.*, 2020a). In Canada, 68% of adults (18 years and older) reported encountering COVID-19 misinformation on at least one of the social media sites or messaging apps they use (Gruzd & Mai, 2020b). Eighty percent of Facebook users, and approximately 70% of Reddit, Twitter, TikTok, and YouTube users, reported seeing misinformation on these sites at least sometimes (Gruzd & Mai, 2020b).

Private messaging apps, such as Telegram, WhatsApp, and Signal, have also been linked to the spread of misinformation (Gursky *et al.*, 2021; Mantas, 2021). Over 80% of adults 18 to 34 years old in Canada were monthly active users of messaging apps in 2020 (Gruzd & Mai, 2020a). They are widely used among diaspora communities, as they offer free connections to family and friends in home countries; however, this feeling of connectivity can also increase one's vulnerability to misinformation, as content is shared privately among trusted loved ones without the scrutiny of fact-checkers or content moderators (Khan & Ramachandran, 2021). The consequences of misinformation spread through messaging apps can be severe. For example, India is home to the largest WhatsApp user base in the world — 390.1 million users (Singh, 2021). Between May and September 2018, false reports of child kidnappers passing through villages were shared on WhatsApp; these were linked by public officials to the incitement of mobs that carried out at least 16 lynchings and led to 29 deaths (Dixit & Mac, 2018).

Economic incentives contribute to the distribution of misinformation on social media

Social media companies primarily generate revenues by selling advertising space, the value of which is driven by users' engagement on the platform (Johnston, 2022; Reiff, 2022). On social media, where anyone can create and share content, misinformation can be created explicitly to drive engagement (i.e., "clickbait"). For example, fake news is a distinct class of misinformation that is designed to look like traditional media sources (Gelfert, 2018). The creators of fake news stories want their stories to go viral in order to maximize influence and advertising revenues; content is therefore drafted to garner engagement and shares irrespective of the truth (Alba-Juez & Mackenzie, 2019; Pennycook & Rand, 2020). Social media platforms have created and proliferated new ways for fake news to target potential audiences by strategically exploiting consumers' cognitive biases and heuristics (Gelfert, 2018; Vosoughi *et al.*, 2018) (explored further in Chapter 5).

These strategies can attract large audiences and generate substantial revenue. The Center for Countering Digital Hate (CCDH, a non-profit NGO funded by philanthropic trusts and members of the public headquartered in Washington, D.C. and London, United Kingdom) calculated US$36 million in revenues reported by the anti-vaccination industry using social media (CCDH, 2021a), as characterized by 22 organizations operated by 12 people (the "Disinformation Dozen," see CCDH, 2021b). Misinformation can be lucrative for both content creators and platforms — the 62 million followers of the Disinformation Dozen were estimated to have generated up to US$1.1 billion in revenues for the social media platforms that host them (CCDH, 2021a).

Unsubstantiated claims about health, nutrition, and "wellness" abound on social media, peddled by influencers and celebrities who sell products and services for profit (Caulfield, 2015; Lofft, 2020). Because wellness influencers are often attractive, with sought-after body types, they are trusted as experts in providing advice and guidance on how to look as good as they do; their appearance gives them credibility in selling the products they purport to use themselves (Lofft, 2020). The use of scientific-sounding mechanisms to explain the success of their diet plans (or supplements, or cleanses) can play a role similar to conspiracy theories — they provide a simple explanation (e.g., "eat this to lose weight") that is difficult to dislodge in the face of an otherwise complex and challenging issue (i.e., weight loss). Influencers build a personal brand and a community of subscribers and other influencers with similar beliefs around food and diet, such that ideas get reinforced by an apparent chorus of like-minded people, whether the underlying information is factual or not (Lofft, 2020). Such patterns of reinforcement are evident on both social media (e.g., CCDH, 2021c) and podcasts, where interactions between guests and hosts can make it seem as if an issue has been thoroughly discussed among informed individuals, despite including exaggerated or disproven claims (for example, see Science Vs., 2022).

Social media functions and algorithms have been used to promote polarization and misinformation uptake

Haidt (2022) claims the development of "likes" and "shares" on social media, and the subsequent ability for content to go viral (i.e., spread rapidly and widely), has led to a decline in the quality of public discourse. The author suggests that social media has provided power to trolls and provocateurs, political extremists, and vigilantes in a way that silences the majority and disincentivizes open discourse (Haidt, 2022). A relatively small proportion of users can manipulate the public discourse (recall the Disinformation Dozen), exploiting it for malicious intent. For example, Russia's Internet Research Agency employs operatives who post and share on social media posing as U.S. citizens with the goal of sowing political discord (US House of Representatives Permanent Select Committee on Intelligence, n.d.). In addition to political content, these operatives create and share science and health misinformation — of 1,959 tweets published through this agency's accounts between 2015 and 2017, 372 (19%) contained misinformation about vaccines (Warner *et al.*, 2022). The vast majority of those tweets (97%) were anti-vaccine in messaging (Warner *et al.*, 2022). According to the Edelman Trust Barometer, 71% of people in Canada worry that misinformation (i.e., false information and fake news) is being used as a weapon, the highest proportion yet recorded by the survey (Edelman, 2022).

Misinformation on social media platforms is also being created and spread by social bots — software robots that create automated social media accounts (Ferrara, 2020; Himelein-Wachowiak *et al.*, 2021). Bots can be used to boost the virality of content and have been found to contribute disproportionately to the spread of misinformation on social media (Shao *et al.*, 2018; Yuan *et al.*, 2019). Approximately 63.5% of known bots were found to have tweeted about COVID-19 in 2020 (Himelein-Wachowiak *et al.*, 2021). Though Himelein-Wachowiak *et al.* (2021) did not examine the content of those tweets to determine the extent to which COVID-19 misinformation was shared, bots have been shown to spread misinformation in other public health domains (e.g., Broniatowski *et al.*, 2018). They can also use trending science and health news stories, such as the COVID-19 pandemic, to spread other kinds of misinformation, such as political conspiracies (Ferrara, 2020).

Social media algorithms recommend content and creators to follow (CCDH, 2021c). Algorithms give priority to content based on engagement, which can result in favouring content that causes an elevated emotional response, especially anger, contempt, and disgust (Abul-Fottouh *et al.*, 2020; Rathje *et al.*, 2021). Such emotional experiences have been shown to impact the well-being of some users of platforms such as Facebook and Twitter (Allcott *et al.*, 2020). They can also influence feelings of animosity toward others; in particular, Rathje *et al.* (2021) found that language about the out-group (Republican or Democrat in the United States) was the strongest predictor of social media engagement, suggesting that these platforms have built in a perverse incentive to amplify out-group animosity and divisiveness. While animosity among people based on affiliation with different political identities (affective polarization) is particularly pronounced and increasing in the United States, Canada is not immune, showing a small but steady rise in affective polarization over the past 50 years (Boxell *et al.*, 2021). The use of social media, particularly Facebook and Telegram, to amplify the 2022 "Freedom Convoy" — which blocked international border crossings and shut down parts of the nation's capital for 20 days, purportedly in protest of public health mandates — is a stark example of the use of misinformation[6] to help fuel polarization in Canada (Coletta *et al.*, 2022; Meyers *et al.*, 2022).

Polarized media consumption occurs across all media sources and the ideological spectrum, but the characteristics of consumption vary among different groups. People across the political spectrum tend to opt for information sources consistent with their political values. For example, in the United States, nearly half of all survey respondents who identified as consistently conservative named Fox News as their main news source (47%), whereas consistently liberal respondents relied on a range of news outlets, such as CNN (15%), NPR (13%), and MSNBC (12%) (Pew Research Center, 2014). As well, the online world supports a greater number and diversity of media options compared to traditional news sources (Fletcher & Nielsen, 2017, 2018). Online exposure to a wider array of news sources suggests that neither media access nor media filtering alone explains the effects of ideological clustering, including the spread of misinformation and increasing polarization (Fletcher, 2020). However, there is substantial evidence that, online, we tend to have more — and stronger — social ties with ideologically similar people (Bessi *et al*., 2016; Mena *et al*., 2020), and that the consumption of ideologically polarized media increases misinformed beliefs across many topics, including science and health (Bail *et al*., 2018).

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[6] For example, the memorandum of understanding drafted by Canada Unity, one of the organizers of the "Freedom Convoy," demands actions by the Governor General and Senate of Canada that are not legally possible in Canada (Canada Unity, 2021; Ling, 2022a). Another group associated with the protest (Police on Guard for Thee) filed a statement of claim in an Ontario court that includes the assertion that the public health measures of masking, social distancing, and PCR testing, among others, are "not scientifically, or medically, based" (Ontario Superior Court of Justice, 2021; Ling, 2022a).

Social media platforms, through their recommendation algorithms, can push users toward more extreme content. Wong (2019) reports that searches for the word "vaccine" on Facebook and YouTube in 2019 directed users toward anti-vaccine misinformation through Autofill suggestions, while Alba (2021a) found that publishers use articles and videos of cute animals as "engagement bait" to acquire subscribers or redirect audiences to a publication or website peddling misinformation. Furthermore, Edelson *et al.* (2020) have documented how inauthentic communities are created and established by cultivating online groups targeted toward users with specific identity markers (e.g., union members, Black women, Ohioans), which are then used as platforms for disinformation advertising campaigns on social media. The Center for Countering Digital Hate (CCDH), moreover, has shown how following Instagram "wellness experts" who are linked to the anti-vaccination movement can lead users to more extreme anti-vaccine content, as well as posts sharing COVID-19 misinformation and conspiracy theories; by following leading anti-vaccination proponents, Instagram users saw algorithm recommendations for posts that included antisemitic content, QAnon conspiracies, and COVID-19 misinformation, irrespective of whether those posts were labelled by the platform as "misinformation" (CCDH, 2021c).

Misinformation spreads through social networks, including online communities

Young (2021) argues that social media and online spaces have created a platform where people can find and become deeply attached to a community, especially in the absence of community in the offline world. These online communities can provide a sense of belonging that in turn creates susceptibility to misinformation (Young, 2021), and participation can lead to selective exposure to messaging that reinforces false beliefs (Guess *et al*., 2020). Social reinforcement of misinformation and confirmation bias[7] is strengthened by our tendency to associate more with people who share similar ideas and values (Bessi *et al*., 2016; Mena *et al*., 2020). Self-segregation can result through one's choice of social media platform, such as Reddit versus Gab (Cinelli *et al*., 2021). Even on a widely used platform such as Facebook, which hosts users with a variety of beliefs, there can be substantial segregation (Cinelli *et al*., 2021). Facebook users who follow similar rather than diverse news pages, who are more polarized, and who embrace conspiracy ideation are also the most susceptible to misinformation (Bessi *et al.*, 2016).

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[7] Confirmation bias is the tendency to seek out information in line with what we already believe to be true (Nickerson, 1998).

People who rely on social media for health information are also more likely to accept vaccine conspiracy theories, such as the belief that vaccine safety and efficacy data are fabricated, or that there is a government or industry cover-up about the harms vaccines cause (Featherstone *et al.*, 2019). Conspiracy-oriented social media users are more likely to engage with false claims that conform to the conspiracy narrative and to ignore debunking efforts (Quattrociocchi *et al.*, 2016). Those who participate in one conspiracy group tend to join many of them, indicating a broad acceptance of misinformation among susceptible communities (Bessi *et al.*, 2015a). Misinformation can circulate for some time within an online community before it diffuses out from the initial platform through weak network ties (Törnberg, 2018). However, online communities do influence the spread of behaviours offline, particularly among highly connected social networks (Centola, 2010; Bessi *et al.*, 2015a). For example, COVID-19 vaccine hesitancy offline is associated with higher levels of social media use (particularly YouTube), as well as belief in COVID-19 misinformation, vaccine distrust, and vaccine conspiracies (Jennings *et al.*, 2021).

2.1.2 News Media

Journalism is essential to having an informed public that is capable of holding our democratic institutions to account. At the same time, news media succeeds by capturing the attention of consumers. This tension between news as a public good and a consumable product is not new — at the turn of the 20th century, the proliferation of inexpensive newspapers in the United States led to a competitive climate for sensationalized stories (i.e., emotional, provocative, and outrageous) that culminated in the printing of fiction indistinguishable from legitimate news (McQueen, 2017). The blurring of fact and fiction that was characteristic of journalism at the time spurred the development of journalism schools and journalistic standards, which sought to create a clear distinction between legitimate news (and news sources) and tabloid sensationalism (McQueen, 2017). Professional journalists are expected to adhere to ethics guidelines that include standards and practices for ensuring accuracy and transparency in their reporting (e.g., CAJ, 2011). Still, news coverage of science and related topics has been (and continues to be) a low priority for mainstream media outlets (Schäfer, 2017), and the growth of media sources both online and among traditional outlets has arguably made it more difficult for us to recognize valid sources of scientific information — making it easier, in turn, to misinform ourselves through the selective use of available evidence and sources (Kahan, 2017).

The proliferation of talk radio, cable news, online message boards, and social media likely contributes to the post-truth era, in which the validity and legitimacy of information and knowledge institutions — in government, academia, science, and healthcare — are increasingly challenged (McIntyre, 2018; Bufacchi, 2021). Trust in news media has declined. In 2020, 42% of people surveyed in a representative sample of adults in Canada agreed with the statement "I think you can trust most news most of the time," a decrease of 13% since 2016 (Newman *et al.*, 2022). Narrative bias in news media pushes science and health journalism toward simple, clean explanations to attract readers; these do not capture the complexity and nuance of what are often complicated and uncertain topics (Cliche, 2020). The number of dedicated science journalists has been decreasing in traditional news media while, at the same time, the online world has led to a pluralization of public communication (Schäfer, 2017). Though online media has created new business models and opportunities for science and health journalism (Schäfer, 2017), such opportunities are also used to capitalize on the creation and spread of science and health misinformation.

Economic incentives influence the type of media content produced and consumed

The expansion of the information environment has impacted the market for media and marketing strategies of media companies. Within the news media ecosystem, private media corporations with stakes in television, radio, and newspapers rely on consumer engagement as drivers of advertising dollars (Demers, 1996; Champlin & Knoedler, 2002; Sacerdote *et al.*, 2020). We have a greater physiological response to bad news and tend to be more attentive to and aroused by negative content (Soroka *et al.*, 2019). Emotional responses correlate with engagement; for example, provocative, negative emotions such as anger and disgust can generate likes, comments, and shares (Zollo *et al.*, 2015; Vosoughi *et al.*, 2018). Among private media corporations (e.g., cable news, talk radio), the demand for engagement appears to result in more negative content than it does among media sources driven by other mandates, such as public broadcasters and local news (Sacerdote *et al.*, 2020). Sacerdote *et al.* (2020) found that major U.S. media outlets published more negatively toned articles about the COVID-19 pandemic compared to major international outlets, and suggest this trend is driven by reader preferences in the absence of a major public media option in the United States. Negatively skewed media coverage can lead to hyper-partisanship, which can, in turn, contribute to a more toxic and polarized online environment (e.g., Recuero *et al.*, 2020; Kim *et al.*, 2021).

Demand for attention biases science journalism toward sensationalism over substance

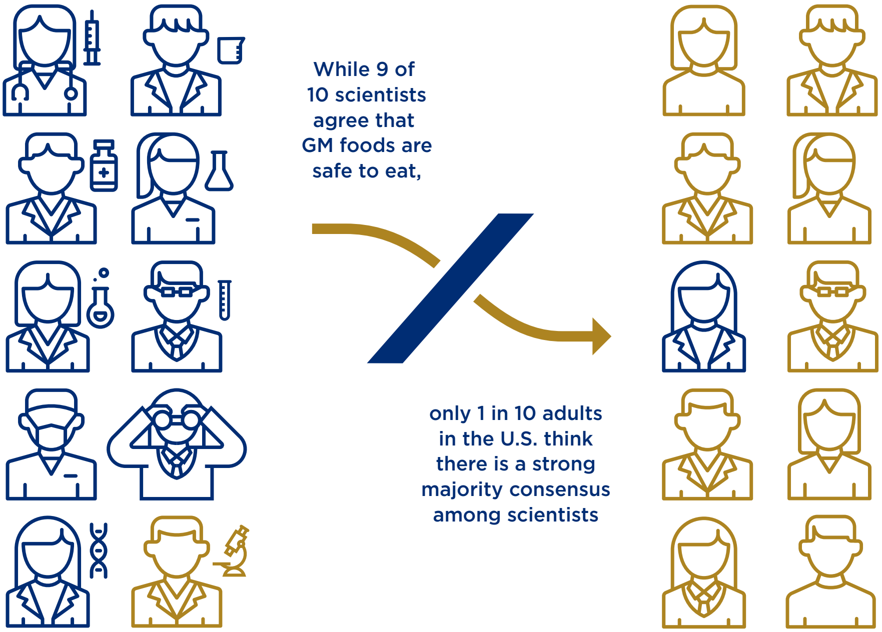
When chasing a story, journalists run the risk of actively biasing their reporting toward sensationalist, outspoken sources who become overrepresented in the media as spokespeople despite a lack of expertise or experience in the subject matter (Cliche, 2020). In a review of 13,532 French-Canadian press articles on shale gas exploration (i.e., fracking) published in 2010, Cliche (2020) found that only 1% (135) of articles cited a geologist or geological engineer. Instead, news articles favoured commentary from local residents, advocacy organizations, farmers, politicians, ecologists, and industry spokespeople over experts who could speak to the scientific evidence. Indeed, over five months of reporting on shale gas exploration in 2010, no one in the Quebec media reported information from an independent expert in the field (Cliche, 2020).

Searching for a compelling headline also biases science reporting toward primary research findings — often individual studies with small sample sizes and large reported effects — rather than systematic reviews or meta-analyses that present the weight of the evidence across a collection of studies (Amberg & Saunders, 2020; Cliche, 2020). For example, in reviewing media reporting on cancer research in the United States (*The New York Times*), United Kingdom (*The Guardian*, U.K. edition), and Australia (*The Sydney Morning Herald* and *Australian Broadcasting Corporation*), Amberg and Saunders (2020) found that 92.5% (74 out of 80 news reports) were based on primary research studies. Primary research involves the direct collection of data, such as through experiments or surveys. While valuable and necessary for advancing science, the findings from any one such study can fail to replicate or translate to a broader phenomenon. Yet, very few news reports identified the limitations of primary research, nor did new reports discuss funding sources or potential conflicts of interest (Amberg & Saunders, 2020).

Interest groups manipulate media practices to distort public understanding of scientific consensus and debate

Some journalistic norms contribute to misinformation, such as the tendency to present both sides of a debate as having equal weight, artificially creating a false balance of perspectives even in cases where the science is conclusive (Koehler, 2016; McIntyre, 2018; Zenone *et al.*, 2022). When presented with comments from an equal number of opposing experts, people perceive lower levels of consensus, even when commentaries are accompanied by data showing that more experts support one side over the other (Koehler, 2016). The effects of a false balance in the media have been observed in the public discourse on climate science, vaccines, genetically modified organisms (GMOs), and nuclear power (Dixon *et al.*, 2015; van der Linden *et al.*, 2015; Dixon, 2016; Bolsen & Druckman, 2018; Chinn *et al.*, 2018; Kobayashi, 2018).

For example, while a substantial majority of scientists (88% of American Association for the Advancement of Science members and 92% of U.S.-based scientists with biomedicine PhDs) agree that GM foods are safe to eat (Pew Research Center, 2015), only 14% of adults in the United States thought there was a strong majority consensus according to a nationally representative survey (Funk & Kennedy, 2016) (Figure 2.2). Fifty-three percent of those surveyed thought that scientists were divided on the topic (i.e., 50% or fewer agree that GM foods are safe to eat), illustrating a substantial disconnect between the reality of the scientific consensus and a perceived unresolved issue among the general public (Funk & Kennedy, 2016).


While 9 of 10 scientists agree that GM foods are safe to eat,
only 1 in 10 adults in the U.S. think there is a strong majority consensus among scientists

Data Sources: Pew Research Center (2015); Funk and Kennedy (2016)

Figure 2.2 Scientific Understanding and Public Perception of the Safety of Genetically Modified Foods

Adults in the United States believe that scientists are still uncertain about the safety of eating GM foods, even though the consensus that GM foods are safe to eat is widely shared among scientists.

The deliberate promotion of an apparent lack of scientific consensus in the news media has had real-world consequences on public health and public policy (Oreskes & Conway, 2010). For example, false-balance media coverage has contributed to the popular misunderstanding of the scientific consensus on climate change (Cook *et al.*, 2017). Between 1988 and 2002, articles published by *The New York Times*, *The Washington Post*, *Los Angeles Times*, and *The Wall Street Journal* that relied on "balanced" reporting created significant distortion — "creat[ing] both discursive and real political space for the US government to shirk responsibility and delay action regarding global warming" (Boykoff & Boykoff, 2004). More recently, a false balance in U.S. and U.K. media stories on natural herd immunity was observed during the COVID-19 pandemic (Zenone *et al.*, 2022). This false balance gave the impression that the natural herd immunity policy was considered to be a reasonable, and even acceptable, policy option by the scientific community when, in fact, most scientists opposed it (Zenone *et al.*, 2022).

Other journalistic norms besides balance can skew the representation of contrarian voices in media. For example, the presentation of contrarian views about climate change continues to be overrepresented in media coverage, not for balance, but rather for context and critique (Brüggemann & Engesser, 2017). Indeed, contrarian voices continue to find a platform in climate change journalism despite an overwhelming recognition of the scientific consensus. This suggests that, while the public may be better informed on the basics of climate change, there may be a lack of coverage of more relevant debates related to policy-making (Brüggemann & Engesser, 2017). Bad actors specifically target and manipulate media outlets by using journalistic norms and standards to amplify misinformation and extremist messaging, and to shift our expectations about what topics of debate in the public discourse are most critical (Phillips, 2018).

2.1.3 Commercial, Political, and Ideological Interests

While the focus of this report is on science and health misinformation, it is challenging to discuss science and health in isolation, as there can be substantial overlap with both the sources and spread of political misinformation. Misinformation has been promoted by ideological agents, both domestic and foreign, who seek to undermine trust in democratic institutions (Tenove & Tworek, 2019; CSE, 2021). For example, science and health misinformation campaigns were part of the "active measures" employed by the USSR's Soviet State Security Committee (Komitet Gosudarstvennoy Bezopasnosti or KGB) and the East German Ministry for State Security (Ministerium für Staatssicherheit or Stasi) to undermine the credibility and global reputation of the United States during the Cold War (Box 2.1). More recently, the RAND Corporation has documented evidence of Russian and Chinese government manipulation of U.S. and U.K. news media to spread conspiracy theories about COVID-19 and public health measures, suggesting science and health misinformation continues to be a tactic employed to serve certain geopolitical goals (Johnson & Marcellino, 2021).

Box 2.1 Soviet Active Measures Spread HIV Misinformation

Selvage (2019, 2021) chronicles the actions of Soviet agencies to legitimize and spread the false theory that HIV was created by the U.S. government as a bioweapon. While the theory was already circulating among gay newspapers in the United States prior to the involvement of the KGB and Stasi, these organizations amplified and modified the theory to provide additional details (e.g., HIV originated from the U.S. Army Medical Research Institute of Infectious Diseases in Fort Detrick, Maryland) and published it in KGB-backed media outlets. Such news articles prompted responses from Western media that further amplified the reach and penetration of the theory. The goals of this operation (“Operation Denver”) were to expose the dangers of bioweapons research and production, strengthen anti-American sentiment, and spark domestic political controversies in the United States (Selvage, 2019, 2021).

Like COVID-19 conspiracies, the HIV-as-bioweapon thesis appealed because of its ability to offer “clear” answers — and someone to blame — for the uncertainty over the origins of HIV, the lack of effective treatment, and the rapid spread and ensuing panic (Selvage, 2019). Given the death and devastation caused by HIV, the slow response by the Reagan administration in addressing the crisis, widespread stigma and homophobia, and revelations of other covert operations by the U.S. Central Intelligence Agency (including MK-Ultra and the assassination plan for Congolese President Patrice Lumumba), it was not difficult for some in the gay community to believe that the U.S. government played a hidden role in the AIDS pandemic (Selvage, 2019, 2021). The conspiracy was also attractive to many in the African and Black communities, among others, as a welcome alternative to the African origin hypothesis of HIV, but also given Black people’s experiences with U.S. government repression and medical experimentation (e.g., the Tuskegee syphilis study on Black sharecroppers) (Selvage, 2019, 2021).

Misinformation may be targeted to exploit historical mistrust and suspicion for profit

In a similar vein, some misinformation about the COVID-19 pandemic targets Black communities by invoking historical abuses and medical experimentation to sow distrust and vaccine hesitancy (Center for Countering Digital Hate (CCDH), 2021a). Bad actors can manipulate these feelings of mistrust for their own personal gain. For example, notable anti-vaccine activists Curtis Cost, Kevin Jenkins, Robert F. Kennedy, Jr., and Tony Muhammad produced a propaganda film in 2021 that falsely claimed Black people are being used as experimental subjects and are disproportionately being harmed by the COVID-19 vaccine. This film, promoted and shared across anti-vaccine social media accounts, also solicits donations for Children's Health Defense, an anti-vaccine organization founded by Kennedy that hosts the film on its website. Children's Health Defense reports annual revenues of over US$2.9 million and pays a US$255,000 salary to Kennedy (CCDH, 2021a).

Misinformation has been created to sow doubt and undermine the credibility of experts

Traditional information sources, such as scientific publishing, press releases, and news media, can be manipulated to create the appearance of a scientific debate where none exists (Oreskes & Conway, 2010). For example, in 1991, the U.S. Western Fuels Association created two organizations to challenge the scientific evidence on climate change: the Information Council for the Environment and the Greening Earth Society. These were positioned as independent from industry and given names that implied a pro-environmental stance (Oreskes, 2010). Marketing campaigns under the Information Council for the Environment brand called into question the reality of global warming and built the impression that the science was unsettled; meanwhile, the Greening Earth Society promoted the notion that increasing concentrations of atmospheric carbon dioxide would benefit plants, with the goal of shifting public opinion and delaying climate action (Oreskes, 2010). Fake experts (i.e., scientists without relevant expertise, but with plausible degrees and credentials in other fields) have also been used to promote misunderstanding of the scientific consensus on climate change in the news media (Box 2.2).

Box 2.2 The Global Warming Petition Project

Launched in 1998, the Global Warming Petition Project stated that there was no convincing evidence that human-generated greenhouse gas (GHG) emissions lead to catastrophic warming or climate disruption (GWPP, n.d.-a). It was signed by over 31,000 scientists, the vast majority of whom were not climate experts (Cook *et al.*, 2018; GWPP, n.d.-b). Despite the signatories' lack of expertise and the fact that they represent a very small share of scientists overall, the survey proved highly salient and was the most popular climate story on social media for six months in 2016, having been shared, clicked, or liked over half a million times on Facebook (Readfearn, 2016; Cook *et al.*, 2018). A smaller 2019 petition denying the human influence on climate change was also found to be signed primarily by those with little to no research activity in the field of climate change (Caserini *et al.*, 2021).

In addition to human causes of climate change, the role of chlorofluorocarbons (CFCs) on ozone depletion, the relationship between pollution and acid rain, and the link between smoking and lung cancer are all examples where doubt was manufactured and promoted in public and political forums long past the time when scientific consensus was reached (chronicled in Oreskes & Conway, 2010). Valid scientific evidence and consensus on the safety and health benefits of fluoridated drinking water and mumps-measles-rubella (MMR) vaccines have also failed to end ongoing public disputes over their potential harms (e.g., Pluviano *et al.*, 2017; MacVicar, 2021).

Misinformation is created and promoted in support of political ideologies

Between 1972 and 2005, 92% of 141 books published in English that denied "the authenticity of environmental problems," including climate change, were affiliated with, or published by, conservative think tanks (Jacques *et al.*, 2008), and almost two-thirds of conservative opinion columns written between 2007 and 2010 argue that there is no consensus on human-caused climate change (Elsasser & Dunlap, 2013). In Canada, Calgary-based Friends of Science has been claiming since 2002 that solar activity is the key contributor to climate change (Greenberg *et al.*, 2011). The organization has engaged with the media and public on this message, funding political advertisements, hosting public events, and contributing newspaper op-eds (Greenberg *et al.*, 2011). It is difficult to trace the funding sources behind Friends of Science, but the fossil fuel industry is among its contributors (Montgomery, 2006;

Gorrie, 2007). The activities of Friends of Science are ongoing, with the organization regularly issuing press releases questioning climate science and policy (Friends of Science, 2022). Perhaps unsurprisingly, right-wing and conservative political ideologies are correlated with climate change skepticism in the United States and Canada (Hornsey *et al.*, 2018).

2.1.4 Science and Health Institutions

In some circumstances, quality of information and reliability of sources are necessarily held to high standards. For example, with respect to medications in Canada, strict standards are applied to the accuracy and presentation of treatment claims, adverse effects, and ingredients (HC, 2015). When it comes to decision-relevant science and health information, we must usually trust others to relate what is known about an issue (e.g., scientific or medical authorities), as no one person is equipped to verify or understand all aspects of all topics (Kahan, 2017).

Scientific and medical research is held to a standard of research integrity by a variety of actors, including funders, regulators, academic institutions, and publishers. Most research within publicly funded institutions in Canada is supported by three funders — the Tri-Agencies[8] — which set rules of eligibility that govern research integrity and misconduct (CCA, 2010). They also publish a framework for the responsible conduct of research that covers funding applicants, managers, researchers, and publications (GC, 2021a). While research conducted by federal, provincial, and territorial government departments and agencies is not typically bound by funding arrangements with the Tri-Agencies, it too follows codes of ethics and values and may be bound by codes of conduct through professional bodies (HAL, 2009; CCA, 2010). Private-sector research may be conducted under company-specific policies governing research integrity, though there is no legal requirement for such policies (HAL, 2009).

Scientific research articles also typically undergo a peer-review process prior to publication, intended to ensure that published findings meet standards of scientific rigour and replicability (Ferreira *et al.*, 2016; Ritchie, 2020). Published research itself is subjected to ongoing scrutiny as other scientists build upon earlier findings to refine the state of knowledge. When scientists collectively endorse the same views and cite the same sources, it signals that the finding is considered reliable and conclusive and thus reflects a scientific consensus (Shwed & Bearman, 2010). Science is advanced in practice by sharing research methods and findings through publication, and by the scientific community holding those methods and findings up to collective scrutiny through peer review and replication (Merton, 1973; Ritchie, 2020). However, science is performed by people within systems and institutions, and people, systems, and institutions are fallible.

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[8] The Canadian Institutes of Health Research (CIHR), the Natural Sciences and Engineering Research Council of Canada (NSERC), and the Social Sciences and Humanities Research Council of Canada (SSHRC).

Misinformation is sometimes the product of systemic failures in science and medicine

Scientists sometimes report findings that do not replicate, use weak methodologies, or include errors (Goldacre, 2008; Ritchie, 2020). Systems and institutions may be poorly designed, exploited, or perverted for personal gain, and scientists who bring forward concerns may be ignored by publishers and administrators with their own reputations to protect (reviewed in Ritchie, 2020). Those who bring forward concerns about published research have sometimes faced intimidation, gaslighting, and legal repercussions (e.g., Pennisi, 2020; Bolnick, 2021; Piller, 2022). The mandates of granting agencies and other funding sources overwhelmingly encourage novel exploration, not replication — a tendency reinforced by publishers, many of whom explicitly demand that submitted manuscripts reflect a novel finding, even if the replication has resulted in a new understanding (Ritchie, 2020). The system itself offers limited incentives for scientists to critically examine, replicate, and refute the work of other scientists (Ritchie, 2020).

Slow action against fraudulent research lends credibility to misinformation

Published research that is later recognized as incorrect or problematic may be retracted by the publisher, sometimes at the request of the authors, and sometimes following an investigation (Ritchie, 2020). Research misconduct — such as falsified data, plagiarism, or a lack of ethical approval — is the most common reason for retraction across a variety of fields (Coudert, 2019; Dal-Ré & Ayuso, 2019; Nair *et al.*, 2020). While retractions are rare in the scientific literature — around 3 out of every 10,000 published papers (0.03%) are eventually retracted (Coudert, 2019; Nair *et al.*, 2020; Ritchie, 2020) — failures to address such cases in a timely manner can perpetuate errors or fraudulent findings with potentially damaging consequences. Even after problematic research is retracted, which can typically take between five to eight years (Dal-Ré & Ayuso, 2019; Nair *et al.*, 2020), disproven information can continue to circulate, for any number of reasons, in a way that undermines public confidence in apparent experts or credible institutions (Box 2.3). These failures within scientific and health institutions create opportunities for malicious actors to manipulate and delegitimize science and health information, while the responses of institutions themselves can further damage their reputation and legitimacy in the eyes of the public (Ritchie, 2020).

Box 2.3 A Fraudulent Link Between the MMR Vaccine and Autism

A well-known example of a slow institutional response to fraudulent research involves the medical journal *The Lancet*, which — despite serious, well-documented concerns brought to the attention of the editors in 2004 — took an additional six years to publish a retraction for the 1998 article by Wakefield *et al*. that falsely reported an association between MMR vaccination, gastrointestinal disease, and autism (Eggertson, 2010; Deer, 2011). In the interim, the fraudulent article loaned legitimacy to another study linking autism and vaccines, and provided a platform for, and credibility to, the former's lead author, Andrew Wakefield, who is seen by some as a champion for vaccine hesitancy (Eggertson, 2010; Mnookin, 2011). The study led to an increase in negative media attention around the MMR vaccine and an estimated increase of 70 MMR injury claims per month from 1990 to 2019 in the United States (Motta & Stecula, 2021). There was also a documented decline in MMR vaccine uptake to below 80% at times in the United Kingdom following the media attention; a sustained rate of 95% vaccine uptake is needed to prevent measles outbreaks (Smith *et al*., 2007). Moreover, despite findings by the United Kingdom's General Medical Council of Wakefield's dishonesty, actions against the best interests of his patients, and mistreatment of developmentally delayed children — which led to his being barred from practising medicine in the United Kingdom — Wakefield continues to be a celebrated and outspoken proponent of the anti-vaccination movement (GMC, 2010; Vaxxed, 2016).

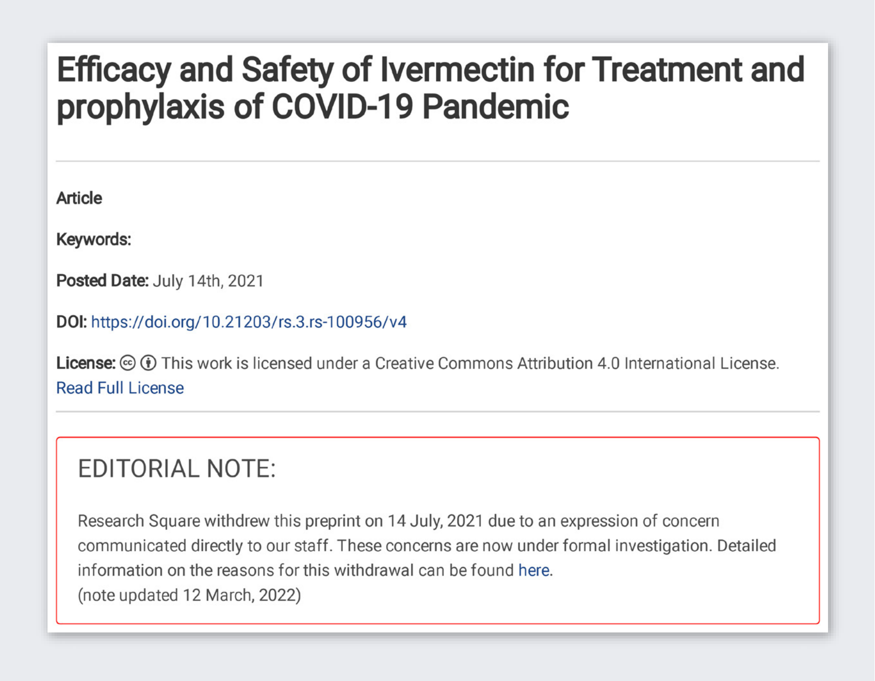
For scientists, job security is based on the ability to continually produce high-quality research, which is measured by the number of publications in top journals and the acquisition of large or prestigious funding grants (Stephan, 2012; Ritchie, 2020). In response to these pressures, scientists may game the academic publishing world by spinning research findings to appear more novel, important, and relevant in their manuscripts (Caulfield & Condit, 2012; Caulfield *et al*., 2016; Wayant *et al*., 2019). However, the machinery of science should, in theory, reduce such distortions over time — through replication, systematic reviews, and meta-analytic techniques that examine the weight of the evidence for any one phenomenon (Ritchie, 2020). For example, individual studies published in scholarly journals have shown both increases and decreases in the relative risk of cancer associated with consuming 40 common food items, including potatoes, milk, coffee, and eggs (Schoenfeld & Ioannidis, 2013). When all the studies on a food item are examined together in a meta-analysis, the effect of consuming a food item on relative risk of developing cancer is substantially reduced in size. Moreover, relative to the individual studies, only half as many of the meta-analyses find any effect — either positive or negative — on the relative risk of cancer (from 72% among individual studies to 36% among meta-analyses) (Schoenfeld & Ioannidis, 2013). Because of such trends, scientists are generally trained to be skeptical of individual research findings; however, most people not trained in science are interacting with such research through the intermediaries of press releases and news articles which, as noted earlier, are biased toward the more sensational findings of primary research (recall Amberg & Saunders, 2020). No one study can be treated as definitive; scientific consensus is built over time, with studies made public so methodologies can be scrutinized, findings tested and retested, and explanations discarded when contradicted by the evidence.

Exaggerated press releases result in misleading science and health news stories

Science- and health-related news stories may be the product of science and health journalists with some expertise in the subject areas; however, they can also be the communication products of institutional press offices reprinted uncritically as news stories (Heyl *et al.*, 2020). Academic press releases are both science communication and public relations; media offices use press releases to build the reputations of research institutions (Autzen, 2014). As such, there is an incentive to hype research findings in press releases. In examining 462 biomedical and health-related press releases from leading universities in the United Kingdom, Sumner *et al.* (2014) found that 40% contained exaggerated advice (e.g., advice on changing behaviours or policies not included in the published study) and 33% contained exaggerated causal claims (e.g., a correlation misrepresented as causation). Thirty-six percent contained exaggerated inferences, such as the claim that “a pregnant mother’s stress level affects the brain of her unborn baby,” drawn from research done in mice, not humans. These exaggerations were reported uncritically in the majority of subsequent news stories (Sumner *et al.*, 2014). The incentive for media to publish stories about novel scientific and medical findings outweighs any incentive to publish follow-up studies that revise or refine more provocative early findings (Cliche, 2020; Goldenberg, 2021). Thus, we may be left with what appear to be important research findings (as reported in the media) that are also confusing and contradictory, with unclear implications for what such findings mean for our own decision-making (Caulfield, 2020).

Predatory publishers and pre-print servers may give misinformation a veneer of credibility

Pre-print servers provide an opportunity for researchers to share information faster by uploading draft manuscripts on public websites (King, 2020). Such uploads may be done prior to (or to circumvent) the lengthy processes of editorial and peer review, copyediting, and publication in an academic journal. The use of pre-print servers was seen as particularly crucial during the early days of the COVID-19 pandemic, when the need for rapid advancement in scientific understanding was underscored by rising rates of illness and death. However, pre-prints can also make visible the otherwise hidden processes of scientific publishing, wherein drafts are critiqued by editors and reviewers, revised by the authors, and re-submitted for consideration. Errors of analysis and interpretation can therefore be propagated by uncritical acceptance of, and reporting on, pre-print findings that might otherwise have been caught and fixed prior to publication. As well, some argue that pre-prints, which are published without editorial or peer review, can be used to source misinformation (King, 2020). For example, Nilsen *et al.* (2022) document how misinformation about the origin of SARS-CoV-2 (that it was developed as a bioweapon by the Chinese Communist Party) was spread, in part, by using a pre-print server to exploit open science and provide an air of credibility. Pre-prints have also contributed to misinformation about the effectiveness of ivermectin as a treatment for COVID-19 (Figure 2.3).



Efficacy and Safety of Ivermectin for Treatment and prophylaxis of COVID-19 Pandemic

Article

Keywords:

Posted Date: July 14th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-100956/v4

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EDITORIAL NOTE:

Research Square withdrew this preprint on 14 July, 2021 due to an expression of concern communicated directly to our staff. These concerns are now under formal investigation. Detailed information on the reasons for this withdrawal can be found here.
(note updated 12 March, 2022)

Figure 2.3 An Example of a Pre-Print that Contributed to Misinformation about Treatments for COVID-19

Similarly, predatory publishers — that is, publishers who exploit open-access publication fees by creating open-access journals that look legitimate, but do not hold editorial standards or peer-review the manuscripts — can also be a source of science and health misinformation (West & Bergstrom, 2021). While articles printed by predatory publishers tend to be of noticeably poor quality and have generally low citation rates (Frandsen, 2017), they can be used to mislead the public (West & Bergstrom, 2021). For example, predatory journals can enable the publication of bad science by giving the impression of legitimacy to otherwise discredited medical claims, such as homeopathy (Beall, 2016; West & Bergstrom, 2021).

Debunking misinformation is a time-consuming process

The speed and ease with which misinformation can be created far exceeds the time and effort required to debunk it. Recall, for example, the 12 years between the publication of Wakefield's fraudulent research and its eventual retraction, made possible through investigative journalist Brian Deer's substantial efforts (Box 2.3). Debunking online misinformation can similarly be asymmetrical with its creation, in terms of effort. For example, Gideon Meyerowitz-Katz, an epidemiologist at the University of Wollongong, Australia, estimated it took him at least 12 hours of work to craft a Twitter thread (@GidMK (Gideon Meyerowitz-Katz), 2021) debunking the website IVMmeta.com, which purports to present a real-time meta-analysis of studies examining ivermectin as a COVID-19 treatment (G. Meyerowitz-Katz, personal communication, 2022). Overall, Meyerowitz-Katz estimates that reviewing studies on ivermectin as a COVID-19 treatment has occupied hundreds of hours (G. Meyerowitz-Katz, personal communication, 2022).

2.2 Societal Factors

While the rapid expansion of the information environment — including in the diversity and availability of communication platforms and information sources — is a major driving factor in the creation and spread of misinformation, other societal factors contribute to the pernicious influence misinformation has on our lives. For example, Kavanagh and Rich (2018) describe what they call a system of "truth decay" in the United States. Drivers of truth decay include the cognitive biases and processes that are innate to the human condition (explored further in Chapter 5) and the transformation of the information environment, but also political, sociodemographic, and economic polarization (Kavanagh & Rich, 2018). These, in turn, contribute to the trends of declining institutional trust, increasing disagreement over facts and data, and increasing the relative value placed on opinion in describing reality (Kavanagh & Rich, 2018) — trends that describe what others have called "post-truth" (e.g., McIntyre, 2018).

While this system of truth decay was described in the U.S. context (Kavanagh & Rich, 2018), the Panel emphasizes that many factors are either shared with or paralleled in Canada, and that these factors are essential to understanding the complexity out of which the impacts of science and health misinformation emerge. Truth decay, as described, is neither linear nor unidirectional, with drivers, agents, trends, and consequences influencing each other to different degrees and effects (Kavanagh & Rich, 2018). As such, the socioeconomic impacts of misinformation are both outcomes of, and contributors to, broader social, political, and ideological trends.

The Panel recognizes three main societal factors that interact to exacerbate the creation and spread of science and health misinformation. These are (i) a decline in trust, particularly trust in scientific, government, and healthcare workers and institutions; (ii) increasing polarization and fragmentation along political, social, and economic divides; and (iii) the growth of a post-truth rhetoric that strives to undermine the legitimacy of our societal structures. These societal factors provide the context in which misinformation is created and spread, but also the landscape on which the impacts of misinformation are experienced, which can differ substantially among individuals and communities (explored further in Chapters 3 and 4).

2.2.1 Institutional Trust

Trust has many dimensions (chronicled in Shockley *et al.*, 2016), though, at a broad level, trust can be characterized as either interpersonal (i.e., among individuals) or institutional (Bornstein & Tomkins, 2015). Institutional trust includes trust in government, legislative, law enforcement, educational, media, healthcare, science, business, and service delivery institutions, among others, and is based on one's assessment of an institution's competency, integrity, and benevolence (Schoorman *et al.*, 2015). One key dimension that influences both interpersonal and institutional trust is social trust, or how much an individual feels they can trust others, including people they do not directly know (Siegrist, 2021). Uslaner (2016) calls this "moralistic trust" and believes it is based on the assumption that others share one's own fundamental moral values. Such moralistic trust is particularly relevant to public policy because it describes a situation in which people feel they share common goals and values. We tend to have higher trust in authorities and experts who seem to share our values, and lower trust in those who do not seem to share those values (reviewed in Siegrist, 2021). Sufficient trust is needed to enable institutions to function.

Trust is foundational to the optimal functioning of institutions and social systems

Part of the challenge of living in an orderly society is that its citizens must, at times, behave in ways that may not be in their individual or short-term self interest, but that benefit the group as a whole over the long term (Jackson & Gau, 2015). Public policies that rely on voluntary adherence depend heavily on citizens trusting one another and the institutions promoting the policies; that is, they must believe an action they are requested to take is the right thing to do (Jackson & Gau, 2015). For example, Sarracino *et al.* (2022) found that trust in others and in national governments, as measured by the language used in tweets, predicted compliance with COVID-19 public health measures (in this case, stay-at-home orders) across 10 countries.[9] Savoia *et al.* (2022) note a similar association between corollaries of trust and compliance with public health measures among study participants from Canada, Italy, and the United States. In this study, people who reported not believing that their government responded appropriately to the pandemic, or who felt their government was not being transparent with information about COVID-19, were also more likely to be vaccine hesitant (Savoia *et al.*, 2022).

A person's level of institutional trust is also related to their reported beliefs in conspiracy theories and misinformation. For example, in an online survey of adults from eight countries including Canada, De Coninck *et al.* (2021) find that people who reported higher levels of trust in health authorities are also less likely to hold conspiracy and misinformed beliefs about COVID-19; conversely, people who reported high levels of trust in digital media are more likely to hold such beliefs. Agley and Xiao (2021) similarly find that trust in science correlates with a lower likelihood of believing false COVID-19 narratives[10] among U.S. participants in an online study. The association between misinformation and a lack of trust in scientific and government institutions is also evident in the cases of GM foods (see Paarlberg, 2008) and human-caused climate change (see Oreskes & Conway, 2010). In such cases, misinformation can be both an outcome of the loss of trust, as well as a tool wielded to undermine existing trust and delegitimize knowledge-producing and regulatory institutions.

Only about 50% of people in Canada trust each other, but most still trust scientists and healthcare institutions

Trust is most often measured through survey data, and measurements of trust can vary among survey instruments; still, most surveys find that about 50% of people in Canada trust most other people. For example, about half (47%) of the people surveyed in Canada in 2020 felt that "most people can be trusted;" agreement with that statement was highest among those aged 50 years and older (51%), and lowest among those aged 29 years and younger (41%) (WVS, 2020). Proof Strategies (2022) reports stable levels of general trust over the past four years (2019 to 2022), with 49% of people surveyed in Canada in 2022 agreeing with the statement that most people can be trusted.

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[9] Australia, Belgium, France, Germany, Italy, Luxembourg, New Zealand, South Africa, Spain, and United Kingdom.

[10] These included the narratives that COVID-19 was caused by 5G cell phone networks or by Bill Gates in order to expand his vaccination programs; developed and released as a military weapon; or that the risks of COVID-19 were deliberately exaggerated to restrict liberties in the United States (Agley & Xiao, 2021).

According to the Pew Research Center (2020), 82% of people in Canada say they have some or a lot of trust in scientists to do what is right. Moreover, the vast majority of people in Canada consider investing in science to be a worthwhile endeavour (Pew Research Center, 2021). Still, measurements of institutional trust can vary depending on the question being asked. For example, a nationally representative survey conducted in 2013 in Canada found that, while attitudes toward science were generally positive (e.g., 72% agreed that "science and technology are making our lives healthier, easier, and more comfortable"), 41% expressed concern in the trustworthiness of scientists because of the influence of industry funding (CCA, 2014). Analyzing data from the 2011 National Survey of Canadian Public Opinion on Climate Change, Lachapelle *et al.* (2012) found that, while a majority of respondents accepted that climate change is happening (80%), just over a third of respondents felt that scientists acting in their own interests were overstating the evidence for global warming. Trust can also be topic dependent. For example, people surveyed in Canada in 2022 said they trusted scientists (75%) and doctors (78%), but these trust levels drop to 69% and 68%, respectively, when the discussion is about COVID-19 (Proof Strategies, 2022). Such specific distrust of healthcare providers has manifested in protests of COVID-19 public health measures, which spread vaccine misinformation while targeting hospitals in Canada in 2021 and inflicted moral injuries on healthcare workers and other hospital staff (Fox, 2021). Moral injury "describes the challenge of simultaneously knowing what care patients need but being unable to provide it" due to factors outside the control of healthcare providers (Dean *et al.*, 2019).

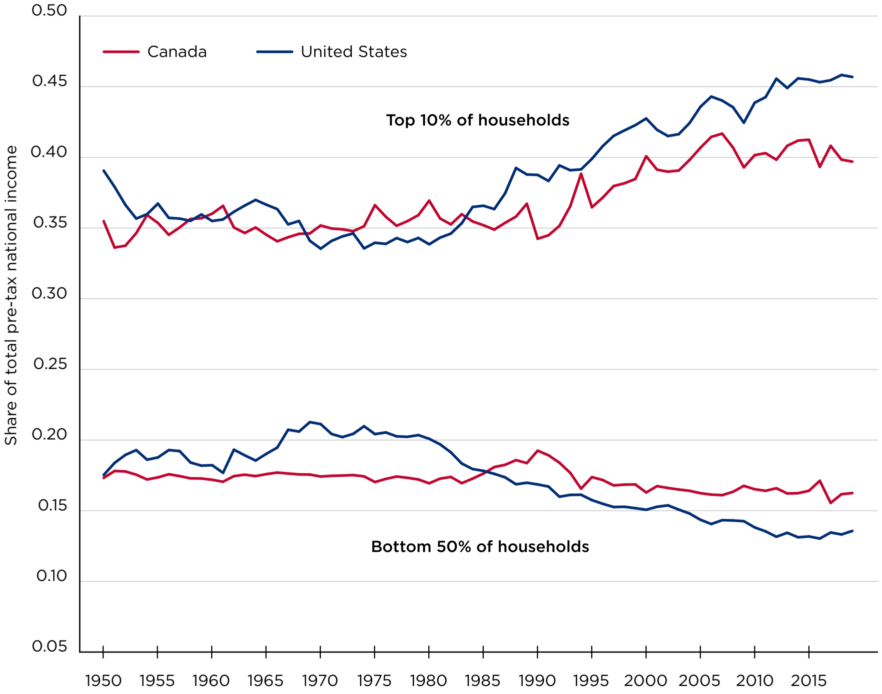
People in Canada are mixed in their level of trust in government, politicians, and news media

Among OECD countries, Canada ranked 12th overall in trust in government in 2020, with 60% of respondents expressing confidence in the federal government (OECD, 2022). In January 2021, 58% of the general population of Canada expressed trust in the government (Edelman, 2021). However, as a profession, politicians were ranked as untrustworthy by 54% of people in Canada surveyed in 2021 — the highest of all professions — followed by advertising executives (45% considered them untrustworthy) and government ministers (43%) (Ipsos, 2021). Some survey data suggest trust in government has been relatively steady from year to year since 2010 (OECD, 2022). Other surveys demonstrate a decline; according to the Proof Strategies (2022) CanTrust Index, trust in the government has dropped from 41% in 2018 to 22% in 2022. Trust in news media has also decreased — in 2016, 54% of a representative sample of adults in Canada reported trust in the news media, compared to 35% in 2022 (Proof Strategies, 2022).

Trust levels vary with socioeconomic status and economic equality

One of the strongest predictors of trust in government and institutions across and within different countries is equality (Uslaner, 2002; Rothstein & Uslaner, 2005). Rothstein and Uslaner (2005) argue that the equitable distribution of economic resources and opportunities is fundamental to people believing that they share a common fate and moral values. When income distributions are highly unequal, social solidarity declines (Rothstein & Uslaner, 2005). Notably, in Canada and the United States, income inequality has risen over the last 50 years (Figure 2.4).

Wu *et al.* (2022) found that socioeconomic status explained the trajectory of trust experienced by individuals during the COVID-19 pandemic. Overall, among Canadian workers surveyed in September 2019, about 72 out of 100 respondents would say most people can be trusted, with 85 out of 100 saying they trust their neighbours (Wu *et al.*, 2022). While neighbourhood trust declined slightly over the course of the COVID-19 pandemic (down to 82 out of 100 by February 2021), general trust remained stable (Wu *et al.*, 2022). However, people with low economic resources and social status tended to have lower initial trust, and to lose more trust, in others during the pandemic, whereas people with moderate and high socioeconomic status either experienced stable or increasing levels of trust in others, respectively (Wu *et al.*, 2022).



Data Source: WID (2022)

Figure 2.4 Growing Income Disparity in Canada and the United States

Over seven decades, the difference in the share of pre-tax national income between the top 10% wealthiest households and the bottom 50% increased in both Canada and the United States. This means that wealthy people are getting richer at a faster rate than poor people.

Our willingness to follow public health recommendations, such as vaccination, reflects our trust in the healthcare system, scientific experts, and government (Greenberg *et al.*, 2017; Frank & Arim, 2020; Jennings *et al.*, 2021). Using data from 84 countries, Elgar *et al.* (2020) found that societies with higher economic inequality also had higher levels of mortality from COVID-19 (from January 22 to September 3, 2020), whereas civic engagement and confidence in state institutions were correlated with fewer deaths from COVID-19.

Experiences of harm and systemic racism undermine trust in our institutions

Though not exclusive to any one group, the legacy and ongoing experience of institutional harm can contribute to skepticism and distrust. Trusting science and health information sources depends in part on a person's individual and community experiences — belief in conspiracy theories, for example, is linked not only to cognitive predisposition, but also to lived experiences and resulting levels of trust in authoritative knowledge institutions (Pierre, 2020). For instance, in Canada, there is a "history of distrust by First Nations towards Canadian institutions," rooted in colonialism, residential schools, Indian hospitals, and ongoing experiences of racism and violence (Phillips-Beck *et al.*, 2020). Through focus groups, Driedger *et al.* (2015) noted that such personal and community histories — including subjection to medical and nutritional research without consent — informed Métis participants' concerns over prioritized access to the H1N1 flu vaccine. Participants questioned the intentions of public health institutions — whether those institutions were truly trying to protect vulnerable populations from outbreaks or were using Indigenous communities to test the vaccine prior to releasing it to the general public (Driedger *et al.*, 2015).

Building trust through open exchanges and community-based dialogue is necessary for appropriate risk communication, as well as for understanding the specific concerns and information environment experienced in different communities (Driedger *et al.*, 2013, 2015). For example, the priority status of "anyone of Aboriginal ancestry" as a high-risk group contributed to stigmatization based on ethnicity during the H1N1 pandemic and did not provide any explanation of the socioeconomic and other disparities, caused by colonialism, that contributed to the decision to prioritize an entire population (Driedger *et al.*, 2013). However, communication strategies during the H1N1 pandemic were improved through collaboration with Indigenous organizations and, ultimately, the rate of immunization among First Nations people in Manitoba was higher than that of the total population (approximately 60% versus 37%, respectively) (Gov. of MB, 2010).

2.2.2 Polarization

Polarization is "a configuration of political and social relations, characterized by a heightened degree of contention that influences beliefs, attitudes and values" (Aguirre, 2020). Bafumi and Shapiro (2009) trace a sharp increase in political (partisan) polarization in the United States from the 1980s to the early 2000s, one that is strongly connected to ideology (e.g., conservative, independent, liberal) and issue opinions (e.g., abortion, homosexuality, economic welfare). In partisan polarization, a perceived alignment of values reflects political affiliations. The language of values and morality can be used by politicians as framing devices to further alienate and polarize political discourse (Lakoff, 2014, 2016).

Increasing polarization is a threat to political coordination across ideological divides, limiting the ability of governments to develop and administer policy (Johnston, 2019). Moreover, the polarization of politics along ideological lines arguably supports public policy decisions that do not reflect the preferences of the public (e.g., Bonica *et al.*, 2013). Belonging to a community with shared interests and values ties into our sense of identity, which influences our ability to engage with policy-relevant facts (Kahan *et al.*, 2010, 2011). That is, it is more difficult for us to discuss public policy openly and objectively when the potential outcome of accepting (or rejecting) the information is to become alienated from our community (Kahan *et al.*, 2010).

People in Canada are experiencing an increasingly polarized society (Johnston, 2019; Aguirre, 2020). As in the United States, party election platforms in Canada have become more divided along left/right ideologies since the 1980s (Cochrane, 2010). This partisan polarization in Canada is evident, for example, in attitudes regarding policy on redistribution (Kevins & Soroka, 2018), though the role polarization plays in other policy areas, such as energy and the environment, remains understudied (Aguirre, 2020). Still, based on evidence from other jurisdictions, Cleland and Gattinger (2019) identify the influence of polarization and partisanship on policy-making and political decision-making, along with trust levels, as key factors that will drive Canada's energy future.

2.2.3 Legitimacy

Legitimacy captures a person's orientation toward accepting the actions or outcomes of an institution (or person, position, policy, law, etc.) as right and proper, even if they do not agree with them (Barbalet, 2009). For example, while an individual may not agree with the need for a stop sign at a particular intersection in their town, they will still stop at the sign, highlighting the legitimacy afforded to traffic laws regardless of an individual's trust in, or agreement with, the government in power. Legitimacy can be thought of as a precursor to institutional trust that is built on confidence, competence, and procedural justice (i.e., fairness and support for basic human rights) (Schoorman *et al.*, 2015). Justice, trust, and legitimacy are all interrelated, and each can be both an antecedent and a consequence of the others (Hegtvedt, 2015). For example, having a trusting relationship with a doctor can help legitimize the field of medicine for a person, which in turn can inspire trust in our healthcare institutions; the converse is also true.

Misinformation influences trust, legitimacy, and the post-truth era

Many harms attributed to the post-truth era — such as the loss of trust in scientific and medical institutions and expertise, the proliferation of misinformation, and a growing divisiveness rooted in ideology — are being felt in communities across Canada. A number of books have been written about the proliferation of misinformation in the post-truth era, decrying the impact that the campaign against knowledge (or science, or expertise, or the possibility of truth itself) has on social well-being, progress, and democracy (e.g., Rabin-Havt & Media Matters for America, 2016; Ball, 2017; Nichols, 2017; Kakutani, 2018; McIntyre, 2018; O'Connor & Weatherall, 2019). In 2016, Oxford Dictionaries declared *post-truth* to be the word of the year, an adjective defined as "relating to or denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief" (Oxford Languages, 2016). Bufacchi (2021), however, extends the definition of post-truth beyond the influence of objective facts to a phenomenon that subverts the very idea of truth, and is thus threatened by it and actively tries to delegitimize it.

Bufacchi (2021) also argues that post-truth has always been a recognizable phenomenon among totalitarian regimes, but that, in recent years, it has increasingly been supported by powerful actors within democracies. Within democracies, the experience of systematic indifference to, or denial and subversion of, the truth may not be particularly new for all people, especially for those in communities subject to systemic racism (Mejia *et al.*, 2018). For instance, school curricula have misled generations of people in Canada about the history of colonization through omission, racist depictions, exclusion of Indigenous perspectives, and narratives focusing on European explorers and nation-building (TRC, 2015a). Therefore, characterizing current public discourse in Canada as "post-truth" may not resonate with many Indigenous people living through a non-Indigenous awakening to the facts surrounding Canada's colonial history and policies. Such reckonings include the publication of the Truth and Reconciliation Commission's final report, the discovery and mainstream media coverage of unmarked graves of Indigenous children at former residential school sites, and the Quebec coroner's finding of institutional systemic racism following the death of Joyce Echaquan (TRC, 2015b; Kamel, 2020; Deer, 2021). Similarly, activism and media coverage of Black Lives Matter rallies around the world (including in Canada) following the death of George Floyd injected the public discourse with the reality of the lived experiences of Black people in Canada — particularly their experiences with police — that have been otherwise ignored or invalidated (Oyeniran, 2020; Raymond & Griffin, 2020; Kalvapalle, 2021).

Though legacies of harm and ongoing systemic racism demand institutional action to actively build trust and establish legitimacy, misinformation threatens such actions and can be weaponized to undermine trust and delegitimize institutions. For example, misinformation designed to undermine the legitimacy of scientific institutions has impacted the public's belief that climate change is real and human-caused (Dunlap & McCright, 2011). Shock and chaos misinformation is well situated within a post-truth agenda, as it seeks to "destabilize social relations and societal institutions" (McCright & Dunlap, 2017). As well as causing direct harms to individual health and well-being, the insidious deterioration of public discourse, democracy, and society are often mentioned as feared or realized outcomes of post-truth[11] (e.g., Arendt, 1951; Nichols, 2017). The COVID-19 infodemic implicates misinformation as a causal factor in polarizing public debate and decreasing observance of public health measures, ultimately threatening social cohesion and undermining democracy (WHO *et al.*, 2020). Documented impacts of the infodemic include preventable deaths from COVID-19 (by people who believed the virus was a hoax), illness and death from ingesting poison as a purported cure or prophylactic (including alcohol, cleaning agents, hydroxychloroquine, and similar-sounding chemicals), as well as incidents of arson, vandalism, and assault (Spring, 2020).

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[11] Though Arendt does not use the word post-truth, Bufacchi (2021) argues her description of "modern political lies" aligns with the current description of "post-truth."

3

Impacts of Misinformation on Individuals, Communities, and Society

3.1 Individual Impacts
3.2 Community Impacts
3.3 Societal Impacts
3.4 Research Gaps

Chapter Findings

- At the individual level, science and health misinformation can undermine personal well-being when it drives us away from evidence-based medicine and toward unproven, costly, and potentially unsafe interventions.
- Communities are also harmed by misinformation. Misinformation about vaccination and communicable disease undermines public health, puts communities at risk, and creates considerable healthcare costs.
- Misinformation is eroding the social fabric. Misinformation about climate change, COVID-19, and other topics is stoking societal fractures, contributing to polarization, diminishing public trust, and undermining public policy.

The potential impacts of science and health misinformation are manifold and range in scope (from individual, to community, to societal impacts) and severity (from relatively benign to potentially deadly). For example, home remedies for the common cold, such as gargling with salt water or taking ginseng supplements, have no or unclear benefits based on scientific evidence from randomized controlled trials (reviewed in Allan & Arroll, 2014). However, the impacts of misinformation about the effectiveness of such remedies are largely benign, given that they have no reported harmful effects and can act as a placebo, and because the common cold usually resolves itself in 7 to 10 days without treatment (Allan & Arroll, 2014). By contrast, misinformation about vaccine safety can increase vaccine hesitancy, threatening the efficacy of vaccination programs and intensifying the health, social, and economic harms of vaccine-preventable diseases that can cause severe illness and death (Bliss *et al.*, 2020).

To address the enormous risks of science and health misinformation to well-being and public policy in Canada, the Panel explored impacts at the individual, community, and societal levels, drawing largely from three widely researched areas of science and health misinformation: health and wellness, vaccines, and climate change (Figure 3.1). Within these areas and elsewhere, isolating the specific impact of misinformation on any one decision and its resultant harms presents a formidable challenge (Dubé *et al.*, 2015). For instance, we make choices about our health based on a range of factors, including access to services, lived experience, trust in the healthcare system, and (mis)understanding of the risks and benefits of medical interventions (Dubé *et al.*, 2016; WHO, 2019). Similarly, support for climate change policy is influenced by political identity, values, economic factors, and (mis)understanding of the impacts of climate change and mitigation policies (reviewed in Drews & van den Bergh, 2016). This chapter presents evidence on how misinformation influences decision-making along with evidence on the socioeconomic impacts of these decisions. A detailed investigation of how misinformation contributes to the socioeconomic impacts of vaccine hesitancy in the context of the COVID-19 pandemic follows in Chapter 4.

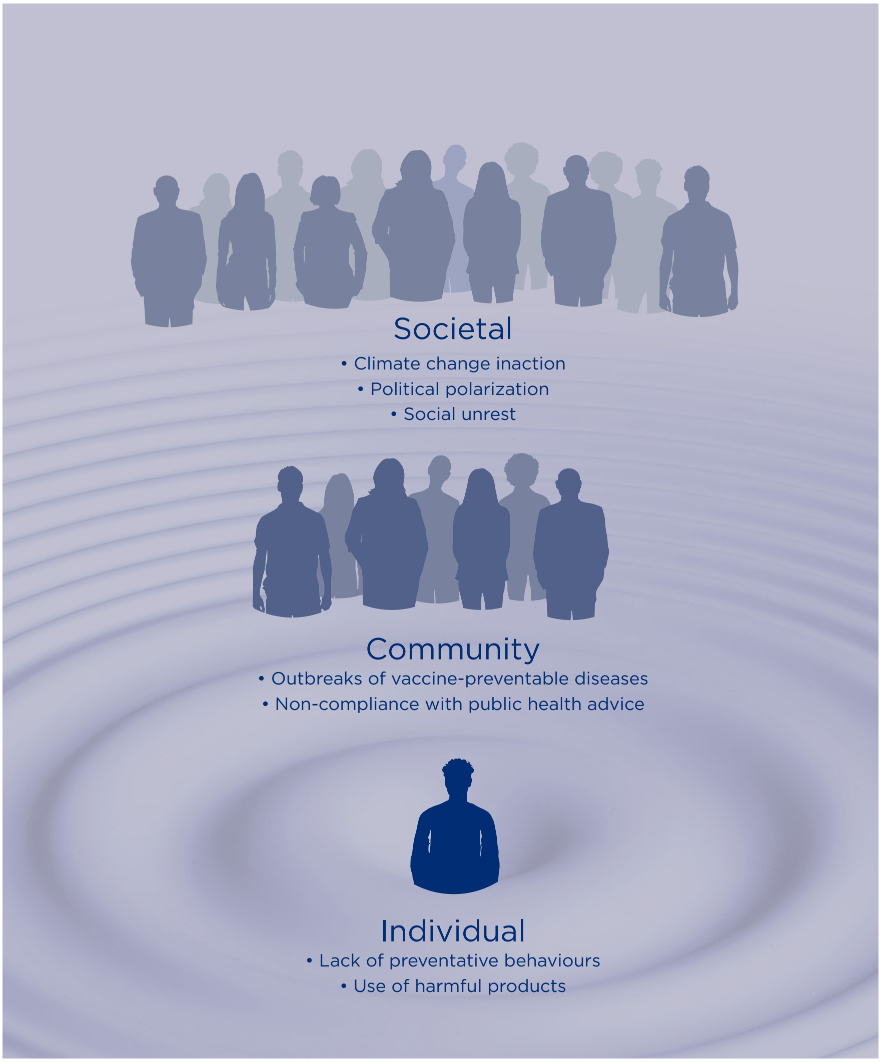

Societal
• Climate change inaction
• Political polarization
• Social unrest
Community
• Outbreaks of vaccine-preventable diseases
• Non-compliance with public health advice
Individual
• Lack of preventative behaviours
• Use of harmful products

Figure 3.1 Impacts of Misinformation Across Scales

The impacts of misinformation are experienced at the individual, community, and societal level. Impacts at the individual or community level can radiate outward.

3.1 Individual Impacts

We encounter a seemingly endless set of health and wellness claims online. Evaluating the reliability of such claims presents a considerable challenge, as misinformation disseminated to serve economic agendas and enhance status circulates alongside reliable, evidence-based advice. When we fail to detect science and health misinformation and instead act on this bad advice, misinformation can cause physical, mental, and economic harms at the individual level.

3.1.1 Individual Health and Wellness

Alternative health and wellness therapies are widely used in Canada, with 79% of respondents to a 2016 survey reporting use of at least one complementary or alternative medicine or therapy at some point in their life (Esmail, 2017). Alternative therapies to evidence-based medicine can provide some value to patients, through, for example, a resonance with individual values and beliefs, the relationships and time afforded by practitioners, and the relief provided (potentially via the placebo effect) (Astin, 1998; Sirois, 2008; Suarez-Almazor *et al.*, 2010). However, the promotion of misinformation about the health benefits of some alternative therapies can create harm by steering people away from effective medical treatments and toward dangerous interventions or misuse of products.

Misinformation can dissuade us from potentially lifesaving preventative behaviours and healthcare interventions

Misinformation can encourage us to make poor decisions about treatments following a diagnosis. Social media is rife with misinformation about cancer cures. *The Independent* found that, “of the 20 most-shared articles on Facebook in 2016 with the word ‘cancer’ in the headline, more than half report claims discredited by doctors and health authorities” (Forster, 2017). Online misinformation regularly proclaims the benefits of a range of supplements in curing cancer (Zadrozny, 2019; Wilner & Holton, 2020). However, research findings underscore the lack of evidentiary support for reliance on complementary and alternative medicine as a primary cancer treatment (Joseph *et al.*, 2012). A sample of Canadian breast cancer patients showed that five-year survival rates were 43% higher among patients who received standard treatments compared to those who refused them and opted instead for complementary and alternative medicine (Joseph *et al.*, 2012). U.S. cancer patients who elected to pursue complementary medicine treatments (e.g., herbs, vitamins, homeopathy) alongside clinical therapies were more likely to refuse clinical interventions and had a two-fold greater risk of death within five years compared to those pursuing only clinical therapies (Johnson *et al.*, 2018a). The use of alternative medicine in place of conventional treatment also lowered survival rates among a U.S. study population, with the scale of impact varying based on the type of cancer diagnosis (i.e., five-fold increased risk of death for breast cancer, four-fold for colorectal cancer, two-fold for lung cancer) (Johnson *et al.*, 2018b).

Misinformation can lead us to use products that harm our health

Consumption of vitamin and mineral supplements in Canada is widespread (StatCan, 2017). While many of the claims supporting the benefits of vitamins and supplements are either unsubstantiated or disproven, beliefs about their efficacy persist (Kamangar & Emadi, 2012; Jenkins *et al.*, 2018; Zhang *et al.*, 2020a). Current oversight practices in Canada have been found to be inadequate for ensuring the safety and efficacy of natural health products (OAG, 2021). Moreover, natural health product labels are often deficient and misleading (OAG, 2021).

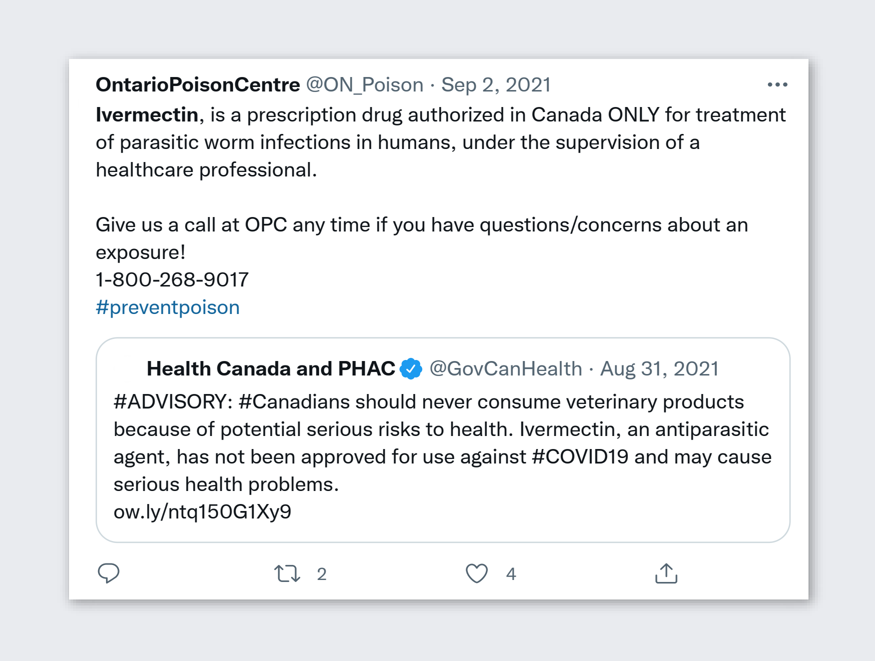
Every year in the United States, roughly 23,000 emergency room visits occur due to adverse events related to dietary supplements, with about 9% of these visits leading to hospitalization (Geller *et al.*, 2015). About 33% of these visits were due to an adverse reaction, another 24% due to allergic reactions, 21% due to unsupervised ingestion by a child, and 10% due to excess doses (the remaining 12% were classified as "other"). Among all the incidents, 66% were associated with herbal or complementary nutritional products — with weight loss and energy products leading the way — and 32% with vitamins and minerals. Heart palpitations, chest pain, and tachycardia (an abnormally high heart rate) were the most common adverse effects associated with weight loss and energy supplements (Geller *et al.*, 2015). On a per-capita basis, the Canadian market for vitamins and dietary supplements is about half the size of the U.S. market (PwC, 2020); these same trends are likely present in Canada, albeit at a reduced scale.

Liver damage is a leading concern when it comes to the use of alternative medicine. The share of drug-induced liver injury attributable to herbal and dietary supplements has increased in the United States, from 7% in 2004–2005 to 20% by 2013–2014 (Navarro *et al.*, 2017). Liver injury can arise from the presence of anabolic steroids in some bodybuilding products, damage from single-ingredient products (particularly green tea extract), or damage from multi-ingredient products, where isolating the ingredients that cause harm can be challenging (Navarro *et al.*, 2017). Liver damage associated with alternative medicines has also been observed in Canada; some reported incidents required a liver transplant, and in one case a patient did not survive (Bergeron *et al.*, 2019).

Misinformation can lead people to take supplements that interact with drugs in dangerous ways. For instance, supplements such as *Ginkgo biloba* and vitamin E can thin blood, and combining these with aspirin or warfarin (which also thin blood) can increase risks of stroke and internal bleeding (US FDA, 2014). Goldenseal (*Hydrastis canadensis*) is used in the treatment of colds and digestive issues, but drug interactions are common, as goldenseal inhibits two key metabolic enzymes (Asher *et al.*, 2017).

Celebrities and social media influencers have created and promoted health and wellness products and services that have no scientific evidence to back up advertised benefits, and even some evidence of potentially severe harms. Gwyneth Paltrow's Goop brand has attracted significant attention for spreading misinformed and dangerous health interventions, including colonic irrigation and apitherapy (i.e., live bee stings) (Handley *et al.*, 2004; BBC News, 2018, 2020; Vazquez-Revuelta & Madrigal-Burgaleta, 2018). In one instance, medical experts warned against the vaginal insertion of jade eggs based on unsubstantiated claims about their ability to balance hormones and regulate menstrual cycles; the cited risks include vaginal bacteriosis and toxic shock syndrome (Gunter, 2017; Tchekmedyian, 2018; Cleveland Clinic, 2021). Paltrow is not alone; Joe Rogan, Aaron Rodgers, Dr. Oz, and Tom Brady are on a long list of celebrities who have promoted health and wellness misinformation (sometimes for commercial ends) in the context of COVID-19 and otherwise (Graham, 2020; Belson & Anthes, 2021; Gabriel, 2021; Bissada, 2022).

During the COVID-19 pandemic, the drugs hydroxychloroquine and ivermectin were identified as possible therapeutic interventions. While scientific research into both was underway, misinformation about their efficacy in preventing and treating COVID-19 circulated widely — in the case of hydroxychloroquine this was largely provoked by then President Trump's retweet of a video on the topic (Haupt *et al.*, 2021). Some claims about ivermectin purported that it was highly effective and that evidence about its benefits was being withheld (e.g., because treatment is inexpensive or may interfere with vaccine approvals); however, there was never sufficient evidence to support ivermectin as a COVID-19 treatment, and the trials were besieged by data irregularities (Blake, 2021; Schraer & Goodman, 2021). Ivermectin use associated with COVID-19 has been reported in Canada, and resultant illness has led to a spike in calls to Alberta's poison control hotline and prompting warnings to the public from poison control centres, Health Canada, and the Public Health Agency of Canada (CBC News, 2021; Harvey, 2022) (Figure 3.2). Within the U.S. Food and Drug Administration's Adverse Event Reporting System, 67% of adverse events associated with hydroxychloroquine between 2007 and the end of September 2021 occurred in 2020 and 2021 (over 15,000 cases during this 21-month period) — overall, almost 8% of cases led to death (US FDA, 2020, 2021).



OntarioPoisonCentre @ON_Poison · Sep 2, 2021

Ivermectin, is a prescription drug authorized in Canada ONLY for treatment of parasitic worm infections in humans, under the supervision of a healthcare professional.

Give us a call at OPC any time if you have questions/concerns about an exposure!
1-800-268-9017
#preventpoison

Health Canada and PHAC @GovCanHealth · Aug 31, 2021

#ADVISORY: #Canadians should never consume veterinary products because of potential serious risks to health. Ivermectin, an antiparasitic agent, has not been approved for use against #COVID19 and may cause serious health problems.
ow.ly/ntq150G1Xy9

Figure 3.2 Public Health Warnings About Inappropriate Use of Ivermectin

3.1.2 Personal Finances

Belief in science and health misinformation can result in individual-level economic costs, particularly when consumers are led to purchase products or services that cannot deliver their purported benefits. This can be particularly damaging for those living on low incomes.

Misinformation about health and wellness may encourage decisions that strain personal finances

People in Canada are estimated to spend close to $200 million annually on homeopathy, and well over $100 million annually on energy healing (e.g., reiki) despite weak or non-existent clinical evidence of efficacy (Cucherat *et al.*, 2000; Ernst & Seip, 2011; Mathie *et al.*, 2014; Rao *et al.*, 2016; Esmail, 2017). There is compelling evidence that routine vitamin supplementation in healthy populations provides no benefit, yet supplement consumption is widespread (Guallar *et al.*, 2013). In Canada, expenditures are estimated at close to $700 million annually (though this has dropped by almost half since 1996) (Esmail, 2017). All told, people in Canada were estimated to have spent $8.8 billion on complementary and alternative medicines in a 12-month period in 2015–2016 (Esmail, 2017).

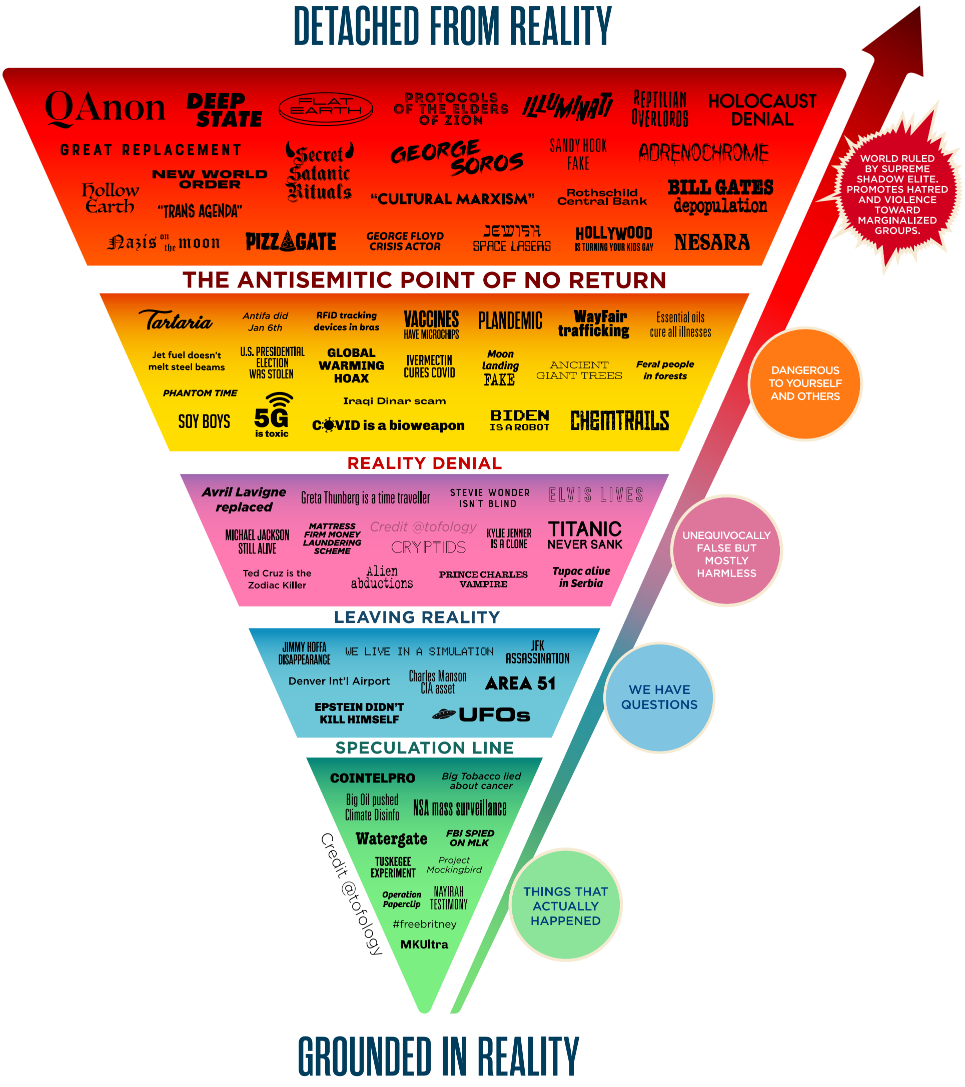
Money is also being spent on inappropriately used prescription medications. In the United States, inappropriate prescription of ivermectin to treat COVID-19 was estimated to have cost private U.S. insurers roughly US$130 million a year in drug purchases alone (with an additional US$82 million in out-of-pocket costs for plan members), and has also burdened taxpayer-funded public insurance systems (Chua *et al.*, 2022).

3.1.3 Susceptibility to Other Kinds of Misinformation

Science and health misinformation can be used to deliberately undermine the legitimacy of knowledge production by scientific and democratic institutions, which can change how we view ourselves as members of society.

Acceptance of one form of misinformation can increase our acceptance of others

Misinformation experts increasingly recognize the phenomenon of *conspirituality*, where wellness misinformation creates an opening for, and susceptibility to, other potentially more dangerous forms of misinformation that are also based on questioning authority and institutional distrust (Wiseman, 2021). Abbie Richards has gained prominence on social media for her TikTok videos combatting misinformation, and for The Conspiracy Chart, which depicts a growing acceptance of conspiracy theories along a pathway from reality to speculation to complete denial of reality (Wiseman, 2021) (Figure 3.3). Ward and Voas (2011) observe that alternative spirituality and conspiracy thinking share some common principles: “a) nothing happens by accident, b) nothing is as it seems, c) everything is connected.”


DETACHED FROM REALITY
QAnon
DEEP STATE
FLAT EARTH
PROTOCOLS OF THE ELDERS OF ZION
ILLUMINATI
REPTILIAN OVERLORDS
HOLOCAUST DENIAL
GREAT REPLACEMENT
NEW WORLD ORDER
Hollow Earth
"TRANS AGENDA"
Secret Satanic Rituals
GEORGE SOROS
"CULTURAL MARXISM"
SANDY HOOK FAKE
Rothschild Central Bank
ADRENOCHROME
BILL GATES depopulation
Nazis on the moon
PIZZAGATE
GEORGE FLOYD CRISIS ACTOR
JEWISH SPACE LASERS
HOLLYWOOD IS TURNING YOUR KIDS GAY
NESARA
THE ANTISEMITIC POINT OF NO RETURN
Tartaria
Antifa did Jan 6th
RFID tracking devices in bras
VACCINES HAVE MICROCHIPS
PLANDEMIC
WayFair trafficking
Essential oils cure all illnesses
Jet fuel doesn't melt steel beams
U.S. PRESIDENTIAL ELECTION WAS STOLEN
GLOBAL WARMING HOAX
IVERMECTIN CURES COVID
Moon landing FAKE
ANCIENT GIANT TREES
Feral people in forests
PHANTOM TIME
Iraqi Dinar scam
SOY BOYS
5G is toxic
COVID is a bioweapon
BIDEN IS A ROBOT
CHEMTRAILS
REALITY DENIAL
Avril Lavigne replaced
Greta Thunberg is a time traveller
STEVIE WONDER ISN'T BLIND
ELVIS LIVES
MICHAEL JACKSON STILL ALIVE
MATTRESS FIRM MONEY LAUNDERING SCHEME
Credit @tofology
CRYPTIDS
KYLIE JENNER IS A CLONE
TITANIC NEVER SANK
Ted Cruz is the Zodiac Killer
Alien abductions
PRINCE CHARLES VAMPIRE
Tupac alive in Serbia
LEAVING REALITY
JIMMY HOFFA DISAPPEARANCE
WE LIVE IN A SIMULATION
JFK ASSASSINATION
Denver Int'l Airport
Charles Manson CIA asset
AREA 51
EPSTEIN DIDN'T KILL HIMSELF
UFOs
SPECULATION LINE
COINTELPRO
Big Tobacco lied about cancer
Big Oil pushed Climate Disinfo
NSA mass surveillance
Watergate
FBI SPIED ON MLK
TUSKEGEE EXPERIMENT
Project Mockingbird
Operation Paperclip
NAYIRAH TESTIMONY
#freebritney
MKUltra
Credit @tofology
GROUNDED IN REALITY
WORLD RULED BY SUPREME SHADOW ELITE. PROMOTES HATRED AND VIOLENCE TOWARD MARGINALIZED GROUPS.
DANGEROUS TO YOURSELF AND OTHERS
UNEQUIVOCALLY FALSE BUT MOSTLY HARMLESS
WE HAVE QUESTIONS
THINGS THAT ACTUALLY HAPPENED

Reproduced with permission: Richards (2021)

Figure 3.3 The Conspiracy Chart

The Conspiracy Chart illustrates that some conspiracy theories are based in reality and actually occurred, but that acceptance of many conspiracy theories demands a degree of speculation and ultimately a rejection of reality.

Conspiratorial thinking in the context of COVID-19 exemplifies some of this overlap and merging of discourses (Sturm & Albrecht, 2021). There appears to be a growing alignment among wellness influencers, support for COVID-19 conspiracies, and far-right politics (Aubrey, 2020; Baker, 2022). In the late winter of 2022, following the Russian invasion of Ukraine, people in Canada who were unvaccinated against COVID-19 were much less likely to agree that Russia was committing war crimes against Ukrainians and less supportive of economic sanctions (Delacourt, 2022). An analysis of news media and social media posts found climate change misinformation circulating amidst pandemic-related misinformation, particularly in relation to the "Great Reset" conspiracy (a belief that the pandemic was planned or is being exploited to reset the global economy) (APCO Worldwide & Logically, 2021). Algorithms can encourage conspirituality, and social media users may even see a deeper meaning when presented with algorithmically curated content because "algorithms have become an important source of self-knowledge as their judgments are seen as objective and trustworthy" (Cotter *et al.*, 2022).

3.2 Community Impacts

When individual choices impact others, misinformation can create harms at the community level. Adherence to public health guidelines, vaccine acceptance, and support for scientific research can all be undermined by misinformation and negatively impact communities.

3.2.1 Public Health and Vaccination

Preventative health measures, such as routine vaccination, are key to maintaining individual health and controlling the spread of communicable diseases; however, those who subscribe to various forms of health misinformation are also less likely to follow recommended preventative practices. This creates risks at the individual level, but also for family, friends, and communities.

Misinformation reduces adherence to recommended preventative health measures

Low institutional trust and belief in misinformation reduced preventative behaviours during an Ebola virus outbreak that began in the Democratic Republic of the Congo in 2018 (Vinck *et al.*, 2019). People who supported conspiracy theories about Ebola were less willing to seek medical care if they suspected they had contracted the disease and were less supportive of quarantine policies (Earnshaw *et al.*, 2019). Similar relationships are observed in the context of HIV — one U.S. study found that Black men who reported higher levels of conspiracy beliefs about

HIV/AIDS also held more negative attitudes toward condoms and reported less consistent use of condoms, such that these conspiratorial beliefs ultimately impeded HIV prevention (Bogart & Thorburn, 2005). People who believe that the U.S. Food and Drug Administration is preventing access to natural cures due to drug company lobbying are also less likely to engage in health-promoting behaviours, such as getting annual physicals or flu shots, or visiting the dentist (even when controlling for socioeconomic status) (Oliver & Wood, 2014).

Acceptance of health misinformation has led some elected authorities to abandon water fluoridation, a key public health tool that limits the incidence of dental cavities. Messaging used to spread misinformation about the health effects of fluoride in drinking water manipulated and simplified the scientific evidence (e.g., by selectively choosing what data to report, and overgeneralizing results) and attached unfounded negative consequences to fluoride use (Armfield, 2007). In the case of Calgary, stopping a water fluoridation program had differential effects across communities and exacerbated disparities in dental cavities, with greater incidence among lower-income households (McLaren *et al.*, 2016).

In the context of COVID-19, the more someone subscribed to conspiratorial beliefs, the less likely they were to comply with a wide range of protective health measures, including staying at home, social distancing, hand washing, and isolating if symptoms arose (Allington *et al.*, 2020; Bierwiaczonek *et al.*, 2020; Roozenbeek *et al.*, 2020a). In Canada, higher levels of exposure to social media (in this case, Twitter) were tied to both an increase in misperceptions about COVID-19 and a decrease in self-reported social distancing compliance compared to those with no exposure (Bridgman *et al.*, 2020). This lack of adherence to public health guidelines creates real-world harms by furthering the spread of COVID-19 — such non-pharmacological interventions are proven methods of reducing individual and community exposure (see, for example, Lin *et al.*, 2020; McGrail *et al.*, 2020; WHO, 2020a; Fazio *et al.*, 2021).

Vaccination, a cornerstone of public health, can be undermined by vaccine hesitancy

Because many vaccines prevent debilitating or deadly childhood illnesses, they confer lifelong benefits and result in substantial healthcare cost savings (Andre *et al.*, 2008; CDC, 2020a). Vaccines also improve educational attainment, lessen health inequity, and prevent lifelong morbidities, improving our social and economic well-being (Bishaia *et al.*, 2003; Bärnighausen *et al.*, 2011; Verguet *et al.*, 2013; CDC, 2020a; BIOTECanada, 2021). Decades of national and international data show that vaccinations are among the most effective and safe public health measures (Shann & Steinhoff, 1999). The WHO conservatively estimates that vaccines prevent between two and three million deaths a year (Vanderslott *et al.*, 2021; WHO, 2021). One recent estimate, which looked at 10 vaccines used in 98 countries, found that, between 2000 and 2019, 37 million deaths were averted by vaccination (Li *et al.*, 2021).

Vaccine acceptance is a complex decision influenced by many factors, such as analysis of risks versus benefits, trust in healthcare practitioners and regulatory bodies, historical and sociocultural considerations, and the media environment (MacDonald, 2015). *Vaccine hesitancy* is "the reluctance or refusal to vaccinate despite the availability of vaccines" (WHO, 2019). Vaccine hesitancy can result from a variety of factors, not just misinformation (Dubé *et al.*, 2016; WHO, 2019) (Box 3.1). We are shaped by our lived experience and, as such, often hold nuanced views that inform our healthcare decision-making; however, some of these nuances can be co-opted and distorted by misinformation (Chung *et al.*, 2017; Czajka *et al.*, 2020; Krause *et al.*, 2020).

Box 3.1 Vaccine Hesitancy

Vaccine hesitancy is a complex phenomenon, with misinformation being only one contributing factor. Needle fear, access barriers, and mistrust also contribute to the delay or avoidance of vaccinations (Taddio *et al.*, 2012; McLenon & Rogers, 2018; IRG *et al.*, 2021; MacDonald *et al.*, 2021). Some people are unable or reluctant to receive a vaccine owing to factors such as allergies to vaccine ingredients, use of immune-suppressing medications, or adverse reactions to vaccines in the past (e.g., Guillain-Barré syndrome, myocarditis) (Roy *et al.*, 2018; HealthLinkBC, 2021; MHO, 2022).

Misinformation contributes to vaccine hesitancy

Vaccine misinformation gained substantial media prominence in the late 1990s thanks to a false and fraudulent study connecting the MMR vaccine to autism[12] (Smith *et al.*, 2008; Godlee *et al.*, 2011) (Box 2.3). This misinformation contributed to a decrease in MMR vaccination rates in the immediate aftermath of the study's release (Smith *et al.*, 2008). Misinformation about vaccine safety is designed to exploit fears, often citing conspiracy theories about covered-up vaccine harms, or fearmongering concerns about improper testing and the inclusion of harmful ingredients (Kata, 2010). This type of misinformation also includes specious claims suggesting vaccines cause neurological, immunological, and mental health problems, or worse, kill people (Chen, 2021). Geoghegan *et al.* (2020) identify several common types of vaccine safety misinformation: fear of many vaccines scheduled close together; vaccines weakening the immune system; impacts on neurodevelopment; the safety of vaccine ingredients; vaccines causing autoimmune diseases; risk during pregnancy; and severe or life-threatening adverse effects.

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[12] These claims have been consistently debunked (e.g., Doja & Roberts, 2006; DeStefano, 2007; Thompson et al., 2007).

A 2016 survey of Canadian immunization researchers, health professionals, experts, policy-makers, and front-line vaccine providers (nurses and physicians) found widespread agreement that vaccine misinformation contributed to vaccine hesitancy (Dubé *et al.*, 2016). In Canada, parents, nurses, teachers, and immunization managers reported that misinformation is the most frequently encountered community-level barrier to Human Papillomavirus (HPV) vaccinations (Dubé *et al.*, 2019). Misinformation about the HPV vaccine was found to be common on online comment boards associated with Canadian news articles, including conspiratorial claims about the trustworthiness of pharmaceutical companies alongside alarming statements about vaccine safety (Feinberg *et al.*, 2015). However, HPV vaccination can substantially reduce the risk of HPV infection, genital warts, high-grade cervical lesions, and invasive cervical cancer (see Lei *et al.*, 2020).

In Canada, 2019 data indicate that over 98% of two-year-old children had received at least one vaccine (PHAC, 2021a). While almost all parents and guardians report believing that vaccines are safe (96%) and effective (98%), 11% also report a belief that alternative approaches can replace vaccines (PHAC, 2021a). Encouragingly, childhood vaccination rates have been stable in Canada in recent years, while belief in the efficacy of alternative approaches, such as homeopathy, is declining (PHAC, 2018, 2021a).

Real-world experiences demonstrate how exposure to misinformation can lead to decreased vaccine uptake. In Denmark, media coverage of suspected adverse events from the HPV vaccine along with a television documentary that reported on disabling symptoms presumed to follow from vaccination were widely disseminated despite a lack of epidemiological studies substantiating these risks (Suppli *et al.*, 2018). Following this negative media attention, rates for HPV-vaccine initiation fell from a previous high of 92% to a low of 42% (Suppli *et al.*, 2018). In Italy, a court ruling recognizing a (non-existent) link between the MMR vaccine and autism created a scenario in which the effects of misinformation could be studied (Reiss, 2015). After the court ruling (which has since been overturned), misinformation spread rapidly, particularly through non-traditional media, leading to a decrease in all vaccination rates, not just for MMR (Carrieri *et al.*, 2019). These examples demonstrate the potential rapid and substantial impacts of vaccine misinformation (Larson *et al.*, 2019).

The Panel notes that demonstrating causal connections between misinformation and vaccine hesitancy is challenging. Experiments can fail to capture the timeframes, environmental conditions, and treatment options experienced in the real world (Findley *et al.*, 2021). When taken in the aggregate, across a variety of experimental methods, the evidence points to misinformation as a cause of vaccine hesitancy. There is no compelling evidence to suggest that vaccine hesitancy, however, leads to misinformation.

Vaccine hesitancy is manifesting in outbreaks of vaccine-preventable diseases

The efficacy of vaccines depends on both individual- and community-level protection from infectious diseases. Community-level protections are the product of herd immunity, wherein a large proportion of a population has been vaccinated and is immune to a disease, potentially leading to the near elimination of person-to-person spread of certain vaccine-preventable diseases (Omer *et al.*, 2009; Anderson *et al.*, 2018).

Vaccine-preventable diseases such as measles, mumps, polio, and pertussis — once believed to be under control — are prevalent in Canada and around the world (e.g., Desjardins *et al.*, 2018; Dubey *et al.*, 2018; Kenen, 2022; Lai *et al.*, 2022). Delays in vaccination uptake are leading to declining protection and growing outbreaks (Wielders *et al.*, 2011; Kershaw *et al.*, 2014; Dubey *et al.*, 2018; Yourex-West, 2019), and vaccination rates consistently fall below targets in Canada (PHAC, 2020, 2021a; GC, 2021b). Because of the relationship between individual and community protection, a decrease in vaccination rates among a small minority of the population can tip the balance between containment and spread in a given area (Burki, 2019). Reluctance among a small fraction of the population can increase disease occurrence, especially where clusters of unvaccinated people exist (Omer *et al.*, 2008; De Serres *et al.*, 2013). A study in Ontario found that the rate of unvaccinated students between the ages of 7 and 17 ranged from 0% to 21.5% by census subdivision (Wilson *et al.*, 2021). In geographic hotspots (i.e., areas with double the provincial rate of unvaccinated students), the risk of vaccine-preventable disease outbreaks was twice to nearly twenty times greater than the provincial average (Wilson *et al.*, 2021). This type of geographical clustering has been linked to real-world outbreaks (Ernst & Jacobs, 2012).

Hesitancy toward the measles vaccine is a particular concern because of the recent global rise in infections and the potent infectivity of the virus (*Measles morbillivirus*), which requires high coverage — a vaccination rate greater than 95% — to achieve herd immunity (Feemster & Szipszky, 2020). Low measles vaccination rates mean that Canada could miss its national 2025 vaccine-preventable disease vaccination targets (PHAC, 2019; GC, 2021b). While most people who contract measles in Canada are unvaccinated, breakthrough infections among vaccinated people do occur, particularly in settings such as schools, where the risk of exposure is exceptionally high (Coulby *et al.*, 2021). In a study of measles cases in Colorado, young children (3 to 10 years of age) living in areas where fewer children were vaccinated faced increased risks of contracting measles, even when they had themselves been vaccinated (Feikin *et al.*, 2000). Complications from measles include hospitalization, pneumonia, encephalitis (inflammation of the brain, which can lead to convulsions, hearing loss, and intellectual disabilities), and death (CDC, 2020b).

Misinformation increases healthcare costs by contributing to vaccine hesitancy

Healthcare costs for treating vaccine-preventable diseases are typically much greater than the cost of vaccination programs (Ozawa, 2016). The cost savings for several vaccines in Canada range from $6 to $45 for every dollar spent on vaccination programs; the most cost-effective programs involve people over 65 receiving the flu vaccine (GC, 2016). A scoping review of vaccination studies in Canada between 1988 and 2015 confirms that, overall, vaccination programs provide a net economic benefit (Rafferty *et al.*, 2017).

Evaluations from international jurisdictions confirm the economic value of vaccines. An investment of US$9 billion through the Global Polio Eradication Initiative has generated net benefits of US$27 billion (Tebbens *et al.*, 2010; Polio Global Eradication Initiative, 2020).[13] In the United States, the benefit–cost ratio for vaccines that are part of the routine childhood vaccination schedule is evaluated at 3:1 for direct benefits, and as much as 10:1 when considering broader societal benefits (i.e., productivity losses from premature deaths, work missed due to illness or caring for others, and uncompensated household labour) (Zhou *et al.*, 2014).

Outbreaks of vaccine-preventable diseases have both healthcare and societal costs (Box 3.2). In a review of 10 vaccine-preventable diseases in the United States, Ozawa (2016) reported that they created an estimated US$9 billion economic burden in 2015, when factoring in costs associated with doctor visits, hospitalizations, and foregone income during the treatment period. Just over US$7 billion (nearly 80%) of this burden was associated with unvaccinated people. An alternate valuation based on the full income approach[14] pegged the cost at US$176 billion (Ozawa, 2016). A different analysis looked at four vaccine-preventable diseases among adults aged 50 and over in the United States and estimated the medical and non-medical costs at US$27 billion in 2013 (McLaughlin *et al.*, 2015).

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[13] An uptick in cases of vaccine-derived poliovirus and its emergence in new countries including the United States and the United Kingdom underscores the importance of ongoing vaccination to contain and ultimately eradicate the virus.

Box 3.2 Estimating the Healthcare and Societal Costs of a Measles Outbreak

In Clark County, Washington, a measles outbreak in 2019 primarily infected unvaccinated people (Pike *et al.*, 2021). The combination of health and societal costs for this outbreak were estimated to be US$3.4 million, including direct and indirect medical costs, as well as lost productivity. Infected people had contact with over 4,000 individuals, all of whom had to be monitored — more than 20% of those contacts were themselves unvaccinated (Pike *et al.*, 2021). A follow-up critique argued that the US$3.4 million estimate was an underestimate, as it excluded cases that occurred outside of the state, volunteer time, and some direct patient costs (Cataldi, 2021). The costs are likely similar to what they would be in Canada, as the costs of treating measles outbreaks are comparable between the two countries (Carabin *et al.*, 2002). Experts have linked these measles outbreaks to anti-vaccine groups and the spread of misinformation (Mandal, 2019; Warraich, 2019; Rodgers & Massac, 2020).

3.2.2 Scientific Research Community

Scientific research does not take place in a vacuum and is instead shaped by both overt (e.g., national and sub-national funding priorities) and subtle forces (e.g., trends in scientific communities). When misinformation circulates in society, it can influence research directions, the framing of results, and even the well-being of scientists.

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[14] According to Ozawa (2016), "in addition to capturing the monetary value of market and nonmarket production, this [full income] method also encompasses the value of lives lost, interpreted as social welfare forgone because of early death."

Public acceptance of misinformation influences research directions and the presentation of research findings

A key misinformation tactic in the climate change debate has been to exaggerate scientific uncertainty (Section 2.1.3). This has influenced the scientific community; many scientists overemphasize scientific uncertainty, which shapes research directions and influences how findings are portrayed (Lewandowsky *et al.*, 2015). In fact, there is a pattern of understatement — not overstatement — of the impacts of climate change in the academic literature (Brysse *et al.*, 2013). Brysse *et al.* (2013) theorize that "pressure from skeptics and contrarians and the risk of being accused of alarmism may have caused scientists to understate their results." While Hansen (2007) suggests that a desire to avoid being later proven incorrect leads groups such as the IPCC to understate the true dangers of climate change (i.e., scientific reticence), Brysse *et al.* (2013) argue that the pattern of understatement is best explained by a desire to avoid being perceived as alarmist. However, when the risks of climate change are understated, policy-makers may opt for an equally understated policy response (Brysse *et al.*, 2013).

Efforts to undermine the science of climate change through misinformation have influenced the focus of scarce research resources. A case study of the contrarian claim that global warming "paused" between 1998 and 2012 found that this assertion received growing traction in the academic literature and was therefore subject to increased research scrutiny (Lewandowsky *et al.*, 2015). The so-called "pause" was in line with previous climate fluctuations, but "the scientific response to this most recent fluctuation differs significantly from the (lack of) scientific response to previous fluctuations that were greater in magnitude but of different sign — that is, previous episodes of accelerated warming above the long-term trend" (Lewandowsky *et al.*, 2015). In brief, the time and effort spent to validate global warming trends was much greater when the data revealed fluctuations that suggested warming was slower, than when fluctuations suggested it was occurring faster than expected.

In the case of GM foods, *The Lancet* attracted criticism for publishing a paper claiming that transgenic potatoes caused intestinal damage in rats (Enserink, 1999). While the majority of reviewers recommended publication, one of them did so on the basis that not publishing the article would further feed suspicions of conspiracy to suppress the findings, despite identifying the study to be flawed. *The Lancet* defended its decision to publish after an unusually rigorous review, but critics — including the U.K. Royal Society and the editor of *The New England Journal of Medicine* — argued that the paper did not meet the normal standards of scientific rigour (Enserink, 1999).

A polarized and aggressive misinformation environment may discourage research in some domains

Controversies and public critiques can have personal impacts on scientists. The 2009 "climategate" controversy provides one such example. The University of East Anglia's Climatic Research Unit had their servers hacked, and emails appearing to suggest that research results were being manipulated were subsequently made public (Leiserowitz *et al.*, 2012). One email exchange referred to a "trick" to "hide the decline," while another referred to problematic gaps in understanding (Revkin, 2009). Despite the appearance of potential data manipulation, extensive academic investigations found that research and conduct were broadly in line with expected practices, and that the research was rigorous (Fischer, 2010; Russell *et al.*, 2010). Some of the scientists implicated in this controversy underwent significant academic investigation, received substantial media coverage, and, in some instances, even received death threats (Leiserowitz *et al.*, 2012).

In a survey of over 300 scientists who have engaged with media on COVID-19, over 15% reported receiving death threats (Nogrady, 2021). Furthermore, among scientists who experience regular attacks, over 20% report that this experience is influencing their willingness to engage with the media in the future; some respondents "have excluded themselves from commenting even on relatively uncontroversial topics" (Nogrady, 2021). In Canada, Wright *et al.* (2022) observe "an increasing and uneven level of risk to individual researchers, particularly for women and BIPOC scholars (Black, Indigenous, and People of Colour)." In a study of 14 female scholars who experienced online harassment, self-protective responses, including self-censorship, were among the most common strategies employed (Veletsianos *et al.*, 2018). Analysis of Twitter responses to tweets from the Chief Public Health Officer of Canada, Dr. Theresa Tam, found harassing vitriol that questioned her credibility, sought to silence her, and included sexist and racist messages (Calasanti & Gerrits, 2021).

3.3 Societal Impacts

Misinformation can manifest in a lack of support and public demand for policies addressing climate change; loss of trust in experts, scientists, healthcare providers, and public health authorities; and increased polarization. It can also be used as a tool to sow shock and chaos, with the purpose of causing social disruption (McCright & Dunlap, 2017).

3.3.1 Public Policy

Misinformation is one factor among many that can shape public opinions on matters of policy. Climate change exemplifies this complexity. The long history of climate change denialism and doubt-mongering continues to influence policy. However, policy support is also influenced by political ideology, economic constraints on consumer behaviour, justifiable skepticism of the effectiveness of public policies, and a host of cognitive biases, including motivated reasoning and inertia (i.e., the tendency to maintain the status quo) (Leiserowitz *et al.*, 2012; Weber, 2015).

Misinformation has reduced public support for climate action

Climate change presents a major threat to Canada and the world (IPCC, 2021). It is leading to loss of sea ice, glacier retreat, an increase in extreme heat, and an increase in heavy precipitation (IPCC, 2021). Canada is warming at about twice the global average rate; its surrounding oceans are warming and acidifying, permafrost is thawing, sea levels are rising, and extreme heat and weather events are more common (Bush & Lemmen, 2019). Over 90% of publishing climate scientists agree that human activity is causing global warming (Cook *et al.*, 2016). These findings emerge consistently across a range of study types, including literature reviews and expert surveys (Cook *et al.*, 2016). However, only 24% of respondents to a U.S. public opinion survey correctly estimated that over 90% of climate scientists accept that human-caused global warming is occurring (Leiserowitz *et al.*, 2021). A Canadian survey found 11% of respondents disagreed or strongly disagreed with the statement "human activities contribute to climate change," compared to 14% of U.S. respondents (Ipsos Global Advisor, 2020). Doubt-mongering is distorting our ability to recognize the scientific consensus, in turn playing a role in delaying or diminishing actions to address climate change.

Several experiments demonstrate the effect that climate change misinformation can have on individual perception and behaviour. One of these involved U.S. college students; it found that exposure to even a few misleading statements about climate change reduced acceptance of global warming and support for funding the United Nation's climate change-related goals mitigation (Ranney & Clark, 2016). When participants in another U.S. experiment were exposed to a denial message about anthropogenic climate change, they were less likely to accept the science, less aware of the consequences of climate change, and less likely to support ambitious climate change policies (McCright *et al.*, 2016). A third U.K.-based experiment presented people with pro-conspiracy or anti-conspiracy information about climate change and found that those exposed to conspiracy theories undermining the scientific consensus felt more powerless, reported greater uncertainty and disillusionment, and were thus less inclined to take actions to reduce their own emissions (Jolley & Douglas, 2014). The conspiracy theory exposure was a modest but statistically significant explanatory factor, suggesting it is a small but meaningful piece of the full decision-making context (Jolley & Douglas, 2014).

A study of adults in the United States found that participants exposed to a conspiracy video that suggested there was an absence of scientific evidence for climate change were 61% less likely to sign a petition about addressing climate change than those in the control group (van der Linden, 2015). These same participants were also less likely to know that the scientific community is in general agreement about human-caused climate change, and somewhat less likely to report an intention to engage in general pro-social behaviours, such as volunteering and donating money (van der Linden, 2015). Reviewing the activities of the conservative movement in the United States between 1990 and 1997, and highlighting the considerable coverage given to climate change skeptics in congressional testimony and newsprint, McCright and Dunlap (2003) argue that misinformation has had an important influence on the failure of the United States to enact meaningful public policies that could advance health and environmental protection. For example, the petroleum industry delayed and obstructed climate policy by sowing doubt and emphasizing scientific uncertainty (Franta, 2021). Decades of stalled progress cannot be recovered and have contributed to the mounting threat of climate change (Franta, 2021).

Inaction on climate change has caused widespread and increasing economic damage

By 2021, the Intergovernmental Panel on Climate Change (IPCC) found the evidence of warming caused by human activities to be “unequivocal” (IPCC, 2021). A failure to meaningfully address climate change is creating a wide range of increasingly severe social and economic harms across Canada and abroad. By 2050 — based on trajectories and the mitigation pledges made by various countries in 2021 — global gross domestic product (GDP) is expected to be 11–14% lower than it would be in a world without climate change, and 7% lower in Canada (Swiss Re, 2021). This analysis also highlights the unequal exposure of different economies to a changing climate, and the disproportionately high risk to the Global South (Swiss Re, 2021). Climate change risks within Canada are also highly uneven and may increase existing inequities (reviewed in Brown *et al.*, 2021).

In Canada, climate change is contributing to extreme heat, wildfires, droughts, permafrost thaw, and flooding (Flato *et al.*, 2019). Warming temperatures will harm health through worsening air quality and extreme heat events (CICC, 2021a). It has been estimated that deaths from extreme heat alone will roughly double and will cost the Government of Quebec $370 million between 2015 and 2065 in ambulance transport, deployment of emergency plans, and doctor consultations (Larrivée *et al.*, 2015). A single heat wave in Quebec in 2018 was estimated to have contributed to

86 deaths (Lebel *et al.*, 2019). Permafrost thaw poses a range of threats, including damage to infrastructure, travel disruptions, and mercury contamination of water and fish, which could accumulate in species consumed by people (Schuur & Mack, 2016; INFC, 2019; Schaefer *et al.*, 2020). Loss of traditional food sources will contribute to food insecurity in Indigenous communities and force reliance on more expensive and less nutritional store-bought foods (Rosol *et al.*, 2016; CICC, 2021a). In a changing climate, sea-level rise, rainfall increases, and temperature changes will damage homes and buildings, transportation infrastructure, and power grids, imposing billions of dollars in costs (CICC, 2021b). In 2020, weather-related disasters caused $2.4 billion in insured damages, and the value of insured losses represents a growing share of GDP over time (IBC, 2021; CCA, 2022). Autumn 2021 flooding in British Columbia interfered with road, rail, and port operations, leading to disruptions in the delivery of food, fuel, and other goods; this event highlighted the cascading nature of extreme weather events, including major supply-chain vulnerabilities (Globe Staff, 2021). One analysis of the British Columbia floods estimated the damages at close to $9 billion (Hunter, 2022). Box 3.3 illustrates one instance of climate change-related misinformation influencing public policy, and describes the ensuing economic impacts felt in a Canadian region.

Box 3.3 Framing Carbon Taxes as "Job Killing"

In 2017, the Government of Ontario established a cap-and-trade system to limit GHG emissions. Public support for this policy was divided (Mainstreet Research, 2017). Some raised concerns that individuals and industry in Ontario would be unfairly disadvantaged relative to other economies with less stringent controls (OCC, 2015). Amidst this debate, misinformation circulated framing Ontario's cap-and-trade system (and other provincial, territorial, and federal climate policies) as a "job killing carbon tax" (The Canadian Press, 2018). In fact, evidence indicates that climate change policies, particularly carbon pricing including carbon taxes, boost levels of employment or leave them unchanged (Yamazaki, 2017; Moffatt, 2019; Pittis, 2019).

Misinformation was used to legitimize the repeal of the cap-and-trade system, with real costs for Ontario. The cap-and-trade system was ultimately revoked only 18 months after its inception (FAO, 2018). In the year of the repeal, Ontario's emissions rose for the first time since they had started a downward trend in 2010 (Environmental Defence, 2020). Repeal of the program also imposed direct costs on the province, estimated at $3 billion in foregone revenues and one-time costs associated with winding down the program (FAO, 2018).

Misinformation has affected other vital policy areas

Misinformation about the risks of nuclear radiation has interfered with efforts to manage nuclear waste in an environmentally conscious way. In 2010, Bruce Power proposed to ship radioactive steam generators across the Great Lakes and down the St. Lawrence River for recycling in Sweden (McCarthy, 2010; Cliche, 2020). Despite extensive analysis and widespread scientific consensus that this plan posed minimal risks, misinformation circulated widely through media channels and led to significant public opposition. Bruce Power ultimately abandoned the project (McCarthy, 2010; Cliche, 2020).

In other instances, misinformation has influenced international development initiatives. For example, a since-terminated agreement saw Global Affairs Canada provide roughly $200,000 in funding to support the deployment of a group of volunteer homeopaths to Honduras offering practitioner training and treatment for Chagas disease (Adhopia, 2019; Valiante, 2019). This agreement risked wasting scarce resources on homeopathic interventions, providing the false impression that they offer a viable alternative to proven conventional treatments (Adhopia, 2019).

The deployment of GM foods has been opposed for many reasons, including general mistrust of the agricultural biotech industry, concern about the creation of economic dependencies between farmers and biotech companies, desire to avoid increased usage of pesticides, and speculations about health and safety impacts on people and the environment (Potrykus, 2001; Greenpeace US, n.d.). But misinformation has also played a role in the GMO debate, particularly through inaccurate claims of the health dangers of consuming GM foods (Potrykus, 2001; Ryan *et al.*, 2020). The case of Golden Rice illustrates how misinformation undermined efforts to address vitamin A deficiency around the world (Box 3.4).

Box 3.4 The Case of Golden Rice

The genetically engineered rice cultivar Golden Rice was developed to reduce disease and mortality associated with vitamin A deficiency — a condition that can result in blindness, and which can exacerbate the effects of diarrhea and childhood diseases such as measles (Zimmermann & Qaim, 2004). This deficiency occurs in parts of the world where people rely primarily on rice as a diet staple (Ye *et al.*, 2000). Over 70,000 children are estimated to die each year in India from vitamin A deficiency, corresponding to two million disability-adjusted life years lost (Stein *et al.*, 2006). The cost estimate for a

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vitamin A supplement program in India is between US$134 and US$599 per disability-adjusted life year; Golden Rice is estimated to lower that cost to between US$3.1 and US$19.4, representing a substantially more affordable public health strategy (Stein *et al*., 2006). The net social benefit of Golden Rice in the Philippines has been estimated to range from US$16 million to US$88 million per year from direct positive health impacts of vitamin A (Zimmermann & Qaim, 2004).

Golden Rice has been embroiled in a larger debate around GMOs, one that features scientific misinformation alongside valid concerns about the nature of the biotech industry and the potential for creating economic dependencies between farmers and biotech companies (Potrykus, 2001; McHughen, 2013). Misinformation campaigns by GMO opposition groups exaggerate claims about the effectiveness of existing vitamin A supplement distribution programs, or suggest that Golden Rice tastes bad or causes problems such as hair loss and sexual dysfunction, among others (Potrykus, 2001). In fact, its development was driven by humanitarian goals with publicly and privately funded research; there are no alternative breeding strategies to address the deficiency of vitamin A in rice; licensing agreements were targeted specifically to avoid creating dependencies by offering seed free of charge indefinitely to those in need; and there are no conceivable negative impacts on public health or the environment (Potrykus, 2001).

Despite the promise of Golden Rice, it has yet to be grown for sustenance anywhere in the world (IRRI, 2021). It was predicted to become commercially available in the Philippines as far back as 2007, but was only approved for planting as of 2021 (Zimmermann & Qaim, 2004; IRRI, 2021). Impediments to Golden Rice approval in India, the Philippines, Bangladesh, and countries in Africa stem from a combination of technological requirements for field testing and development coupled with intensive government regulation (Regis, 2019). While political machinations, economic incentives, human cognition, and global food trade issues complicate measuring the direct impact of misinformation on regulatory burdens for GM foods, the health impacts in this instance are stark. As Regis (2019) concludes, “had Golden Rice not faced overly restrictive regulatory conditions, it could have been cultivated by rice farmers and distributed throughout some of the poorest regions of South and Southeast Asia. It would have already saved millions of lives and prevented millions of children from going blind.”

Misinformation can result in inefficient use of public research funds

Governments use public funds to support scientific research, often aligning research support with public priorities (NSERC, 2018; PMO, 2021). Directing public funds to support research that responds to public concerns can be appropriate and responsible (Douglas, 2021), but, in some cases, misinformation creates pressure for governments to continue to support research even after the science is settled.

Public controversies surrounding GMOs in the European Union have led to substantial and ongoing investments in GM food safety research (Ryan *et al.*, 2020). The European Commission reported spending over €300 million between 1982 and 2010 on GMO safety research, which has broadly concluded that biotechnology is not more risky than conventional plant breeding technologies (EC, 2010). Despite the lack of evidence of increased risk, requirements to conduct 90-day feeding studies in rats for all imported GM foods persist to this day (EFSA, 2021). The controversies surrounding GMOs are multifaceted, with misinformation about safety risks, debates about the role and power of commercial interests in agriculture, and broader environmental concerns all contributing to public opposition (Ryan *et al.*, 2020).

Concerns about the potential link between the MMR vaccine and autism diverted research funding toward original research, systematic reviews, and expert panel assessments in this domain (IOM, 2004; Maglione *et al.*, 2014; Dimova *et al.*, 2020). While the additional studies fully disproved the existence of such a link, the misinformation persists, and the originator of the discredited research has made a career in the anti-vaccine movement in the United States (Sun & Brittain, 2019). The opportunity costs of allocating public funds to this research area are considerable.

3.3.2 Social Cohesion

The concept of social cohesion encompasses social connectedness, cohesiveness, and solidarity (Kawachi & Berkman, 2000). Misinformation can undermine social cohesion when we fail to establish a common foundation of understanding with others. Fractures occur even at a personal level, as exemplified by widespread experiences of family conflict relating to COVID-19 vaccination beliefs and climate change acceptance (Featherstone, 2021; Ferguson, 2021; Valleau, 2021). Online communities are deeply stratified based on vaccine beliefs, furthering echo chambers where misinformation can become deeply entrenched (Mønsted & Lehmann, 2022). Recall Section 2.2, which describes how low public trust and rising political polarization can be detrimental to societal function. A decline in trust and uptake of misinformation can be mutually reinforcing.

Exposure to misinformation may lower public trust and civic engagement

Trust in media and government is key to a well-functioning society, yet such trust is falling in Canada and globally (CIGI & Ipsos, 2019; Newman *et al*., 2020). Experimental evidence demonstrates that misinformation can contribute to a loss of trust, at least in the short term. For example, exposure to an article containing conspiratorial claims about job data from the U.S. Bureau of Labor Statistics led to reduced trust in a range of government services and institutions, including those unrelated to the conspiracies (Einstein & Glick, 2015). In an experiment with U.S. college students, participants exposed to a conspiracy video about the moon landing reported increased distrust in government, even two weeks later (Kim & Cao, 2016). The experiment also identified a feedback loop wherein participants with higher levels of baseline distrust in government were more likely to believe a conspiracy and to report even higher levels of distrust after seeing the video (Kim & Cao, 2016). Exposure to conspiracy theories has also been found to reduce civic engagement. In the United States, one experiment presented people with either pro-conspiracy or anti-conspiracy information about climate change; it found that those exposed to pro-conspiracy messaging experienced a greater sense of political powerlessness, and expressed a reluctance to participate in the political process (Jolley & Douglas, 2014).

Misinformed beliefs and trust in scientists and governments are inversely correlated, but establishing causal links between exposure to misinformation and deterioration in trust is not always possible in real-world studies (see for example, Agley & Xiao, 2021; Pickles *et al*., 2021). Research in the United States by Ognyanova *et al*. (2020) underscores the complexity of this issue. Using a two-wave survey paired with monitoring respondents' online behaviour, the authors examined how exposure to fake news influences trust in political institutions. They concluded that it depends on whether the respondent's favoured political party is in power — for example, in a survey conducted when the government was under Republican control, exposure to predominantly right-wing misinformation bolstered trust in government among Republican respondents (Ognyanova *et al*., 2020).

Misinformation about the benefits and risks of healthcare interventions can be particularly harmful when it negatively affects healthcare decision-making, but it also erodes trust and relationships among patients, healthcare providers, and the wider healthcare system. This trust is already fragile or severely eroded in some groups, especially those who experience systemic racism (Hwang, 2017; Phillips-Beck *et al*., 2020). In Canada, experts report that shifting advice on mask wearing early in the COVID-19 pandemic was interpreted by some as evidence that public health authorities were poorly informed, which reduced trust in medical experts

(CBC Radio, 2020; Zhang *et al.*, 2021a). However, the broader Canadian public appears to have responded well to evolving advice, and public trust remained high during the early days of the pandemic (March to June 2020) (Sheluchin *et al.*, 2020).

Misinformation can contribute to political polarization

There are myriad contributors to polarization, including polarizing leaders who aggravate tensions; the rise of social media; economic growth and inequality; fundamentally conflicting visions for a country; and ideological, religious, and ethnic divides (Carothers & O'Donohue, 2019). In addition, a growing body of evidence suggests that misinformation can contribute to polarization as part of a mutually amplifying cycle. Au *et al.* (2021) draw a direct link between the creation and spread of online misinformation and ideological polarization. Misinformation campaigns in the United States pushed climate change from a formerly bipartisan issue to a highly polarized topic, where public opinion is strongly associated with political affiliation and ideology (reviewed in Cook *et al.*, 2019). In one experiment, left-leaning participants exposed to misinformation about the scientific consensus on climate change became more accepting of climate change, while right-leaning participants become less accepting (Cook *et al.*, 2017). A U.S. analysis of Twitter data found that "information rarely traveled in or out of the right-leaning echo chamber, forming a small yet intense political bubble" (Jiang *et al.*, 2021).

Political polarization may also increase one's susceptibility to misinformation, particularly among right and far-right supporters around the world (e.g., Allcott & Gentzkow, 2017; Deinla *et al.*, 2021). In Canada, belief in COVID-19 conspiracies is highest among those who support the People's Party of Canada, who have not been vaccinated against COVID-19, and who do not trust media and the government (Anderson & Coletto, 2022). Misinformation about COVID-19 helped influence the 2021 federal election, contributing to protests and polarization (Karadeglija, 2021). Social media debates about mask wearing exhibited toxic language at times, creating challenges for health communicators (Pascual-Ferrá *et al.*, 2021). Toxic speech can occur at both ends of the spectrum, among groups calling for the removal of all COVID-19 measures as well as the (relatively smaller) groups calling for greatly enhanced measures, further polarizing online environments (Cliche, 2021). Pascual-Ferrá *et al.* (2021) observe that toxic discourse "creates a hostile environment that turns users away from online conversations about the issue and/or may distract them from acquiring factual, evidence-based information about face mask wearing as an effective measure to stop the spread of COVID-19."

Misinformation is contributing to social unrest

A study of young adults in four Canadian urban settings found endorsement of COVID-19 conspiracies was closely correlated with support for violent radicalization (Levinsson *et al.*, 2021). According to documents from the Canadian Security Intelligence Service (CSIS), extremists have exploited the pandemic and government responses to recruit people to their cause (Spears, 2022). The COVID-19 5G conspiracy is contributing to anger against governments and even violent responses, including harassment of telecom engineers and acts of arson (Devlin, 2020; Jolley & Paterson, 2020). Arson attacks on 5G masts have occurred around the world, creating significant risks by disabling access to emergency services, among other potential harms (Cerulus, 2020; Devlin, 2020).

The "Freedom Convoy" protests that occurred in Ottawa in the winter of 2022 were partially framed around misinformation about the Constitution of Canada and the nature of protection of individual freedoms that it offers — it was also clear that some supporters and participants were influenced by vaccine misinformation (Dickson, 2022; Ling, 2022b; Meyers *et al.*, 2022). These protests disrupted residents and city operations in Ottawa for several weeks at an estimated cost of $36 million to the municipal government, excluding costs to repair damaged infrastructure (Burston, 2022). Costs to retailers were also high, with one estimate pinning the closure of the CF Rideau Centre, a three-level shopping centre in downtown Ottawa, at $23 million per day in lost sales alone (Ki Sun Hwang, 2022). Community disruptions were widespread and included harassment, noise pollution, air pollution, and flooding the local 9-1-1 call centres with false and misleading calls (Connolly *et al.*, 2022; Nardi, 2022).

COVID-19 misinformation has also contributed to anti-Asian racism and xenophobia. Scapegoating and conspiratorial claims that circulated from politicians and elsewhere early in the pandemic contributed to anti-Asian sentiment (Alba, 2021b; Associated Press, 2021). Anti-Asian sentiment is often wrapped up with conspiratorial claims (Alba, 2021b). During the COVID-19 pandemic, Chinese Canadians reported a rise in discrimination to the detriment of their well-being and sense of belonging to Canadian society (Lou *et al.*, 2021).

3.4 Research Gaps

This chapter reviews a large body of evidence pertaining to the influence of science and health misinformation on society and the economy; however, research that can directly attribute science and health misinformation to a specific impact is scarce. Challenges of attribution are significant when drawing from real-world evidence, given the complexity of factors involved in individual decision-making, of which misinformation may only be one. For example, climate change is a particularly challenging area for attribution. While there is direct, short-term evidence from experiments that misinformation impacts public policy support and individual behaviours, there is a lack of research that examines the degree to which misinformation plays a role when compared to other factors, such as political ideology and economic constraints, or in long-term real-world settings. Similarly, there is interest in understanding links between mental health disorders and misinformation, but the causal mechanisms remain unclear — this area of research appears to be in its infancy, particularly with respect to the effects of science and health misinformation (van Mulukom, 2022). Such research gaps contribute to uncertainty in understanding the scale of the misinformation problem.

Thus, research that can further clarify causal mechanisms relating misinformation to socioeconomic impacts in Canada, and that can estimate the relationship between misinformation and socioeconomic impacts, would be valuable. For example, while Canada's Digital Citizen Initiative funds organizations that promote critical thinking about misinformation and engagement in the democratic process, it also funds research on misinformation and its impacts (PCH, 2020). In the United States, current initiatives are looking to build understanding in this domain, including the Mercury Project and the Technology and Social Change Project (Shorenstein Center, 2022; Harvey, n.d.). Chapter 4 of this report seeks to fill some of these research gaps through an in-depth exploration of the contribution of misinformation to COVID-19 vaccine hesitancy in Canada.

4

The Impacts of COVID-19 Misinformation on Vaccination

4.1 Vaccine Hesitancy in the Infodemic

4.2 Modelling the Impacts of COVID-19 Misinformation on Vaccination

4.3 Health Impacts

4.4 Economic Impacts

4.5 Model Limitations

4.6 Broader Socioeconomic Impacts of COVID-19 Misinformation

Chapter Findings

- Misinformation — as estimated by the proportion of those who reported believing that COVID-19 is a hoax or exaggerated — contributed to vaccine hesitancy in over 2.3 million people in Canada between March 1 and November 30, 2021.
- If those who believed COVID-19 was a hoax or exaggerated had become vaccinated as soon as a vaccine was available, hospitalizations would have been lower by an estimated 28% (approximately 13,000 fewer hospitalizations) and deaths would have been lower by 35% (approximately 2,800 fewer deaths) over the same period.
- The costs of hospitalization (including ICU costs) resulting from COVID-19 misinformation are conservatively estimated at $300 million over the same period. This estimate provides only a partial picture of the full costs, as it excludes physician fees, lost wages, outpatient costs, costs of treating long COVID, and wider societal costs.
- The consequences of COVID-19 vaccine hesitancy ripple across society and disproportionately affect racialized and underserved communities, exacerbating existing inequities.

COVID-19 vaccine hesitancy was a key concern in Canada as vaccines became widely available in 2021. The decision not to be vaccinated creates health risks for individuals and communities, imposes healthcare costs, and has economic repercussions across society. In 2021, people who were not vaccinated against COVID-19 were more likely to be hospitalized and die from the virus, and more likely to spread infection to others, while COVID-19 morbidity strained healthcare systems across Canada (Baker & Robinson, 2021; PHAC, 2021b)

Although these harms are well recognized, their magnitude is not well understood. To address this knowledge gap, the Panel commissioned a quantitative economic model to estimate the effects of COVID-19 vaccine hesitancy on health outcomes and hospitalization costs in Canada. When misinformation reduces vaccination rates and leads, in turn, to increased disease incidence, this can ripple across society by straining healthcare systems, creating opportunities for the emergence of new variants, and slowing economic recovery. The impacts of vaccine hesitancy are complex, so morbidity, mortality, and costing estimates were supplemented by additional research on wider societal impacts. Impacts are experienced unevenly across society, reinforcing longstanding inequities. This chapter presents the original modelling work along with existing evidence to provide new insights about the impacts of misinformation during the COVID-19 pandemic.

4.1 Vaccine Hesitancy in the Infodemic

In the winter of 2020, the WHO's Director-General stated that "we're not just fighting an epidemic; we're fighting an infodemic. Fake news spreads faster and more easily than this virus, and is just as dangerous" (WHO, 2020b). This infodemic created fertile ground for the spread of COVID-19 misinformation and contributed to hesitancy as vaccines were deployed across Canada. Misinformation about COVID-19 vaccines disseminated on social media included false claims about their safety, conspiracy theories, and misperceptions of epidemiological risk and vaccine efficacy, among other things (Griffith *et al.*, 2021; Thelwall *et al.*, 2021). Some of the false claims stated that COVID-19 vaccines contain a microchip, that vaccines can alter a person's DNA, and that the vaccine can be shed (and therefore passed to others) (McEvoy, 2021).

Such misinformation can result in both vaccine reluctance (where uptake is delayed) and vaccine refusal. As of August 2021, 7% of adults in Canada were reluctant to receive a COVID-19 vaccine (Abacus Data, 2021, as cited in Anderson, 2021). Reluctant people were likely to report lower trust in government, preferred to avoid vaccines in general, and questioned the speed at which COVID-19 vaccines were produced and approved. An additional 7% of adults in Canada were vaccine refusers — this group was less trusting of doctors and tended to believe that COVID-19 is a hoax or greatly exaggerated, and does not pose a grave threat to their safety (Abacus Data, 2021, as cited in Anderson, 2021). Among the vaccine refusers surveyed by Abacus Data in 2021, 85% believed that vaccine harms are covered up and 73% believed that COVID-19 is a hoax or exaggerated (Anderson, 2021).

Misinformed beliefs exaggerating the risks of vaccines or downplaying the dangers of COVID-19 reduce our willingness to get vaccinated, with subsequent health and economic consequences. In France, for example, support for a range of COVID-related conspiracies among undergraduate students is associated with lower vaccination intentions (Bertin *et al.*, 2020). Across the United Kingdom, Ireland, Spain, the United States, and Mexico, those who are more susceptible to misinformation are less likely to get vaccinated and recommend vaccination to others (Roozenbeek *et al.*, 2020a). Experimental evidence from the United Kingdom and United States has demonstrated that exposure to five images capturing widely circulating online vaccine misinformation can cause an immediate decrease in vaccination intent of approximately 6% (Loomba *et al.*, 2021). In Canada, misinformation and mistrust of experts were identified as barriers to people getting COVID-19 vaccines (Loewen, 2021). People who hesitated or refused to get vaccinated against COVID-19 had a higher chance of contracting the virus and were more likely to experience worse outcomes when they did become sick (PHAC, 2021b; GC, 2022). This resulted in preventable illness, deaths, and costs that accrued over time.

4.2 Modelling the Impacts of COVID-19 Misinformation on Vaccination

The Panel developed a model simulating the COVID-19 pandemic in Canada to quantify the health and economic burdens of COVID-19 vaccine hesitancy due to misinformation

4.2.1 Model Design

The Panel used agent-based modelling to dynamically simulate the COVID-19 pandemic (Figure 4.1). It simulated the behaviour of people in Canada aged 12 and over on a weekly basis from March 1 to November 30, 2021, covering two waves of the COVID-19 pandemic and preceding the spread of the Omicron variant. Each agent in the model was assigned an age, sex, province/territory, vaccination status, and willingness to vaccinate, and the full set of agents reflected the characteristics of the observed Canadian population (StatCan, 2022a). Agents were either acceptant (willing) or hesitant (reluctant or refusing) to receive the COVID-19 vaccine. The amount of misinformation in the population affected the proportion of people who were willing to be vaccinated. Each week, the agents faced some probability of contracting COVID-19, and the corresponding health outcomes were modelled. A complete and detailed description of the model is provided in Appendix A and data sources are listed in Appendix B.

4.2.2 Baseline Model and Hypothetical Scenarios

A baseline model was first simulated to match the observed health outcomes during this period of the COVID-19 pandemic in Canada (i.e., vaccination levels, cases, hospitalizations, and deaths). Agents became vaccinated at the reported weekly rates based on real-world data by age and province or territory (PHAC, 2022). Around 85% of the population was considered accepting of vaccination in the baseline model, based on a large national survey by Statistics Canada (StatCan, 2022b). The remainder of the population was separated equally into reluctant and refusing populations, based on Abacus Data survey results (Anderson, 2021).

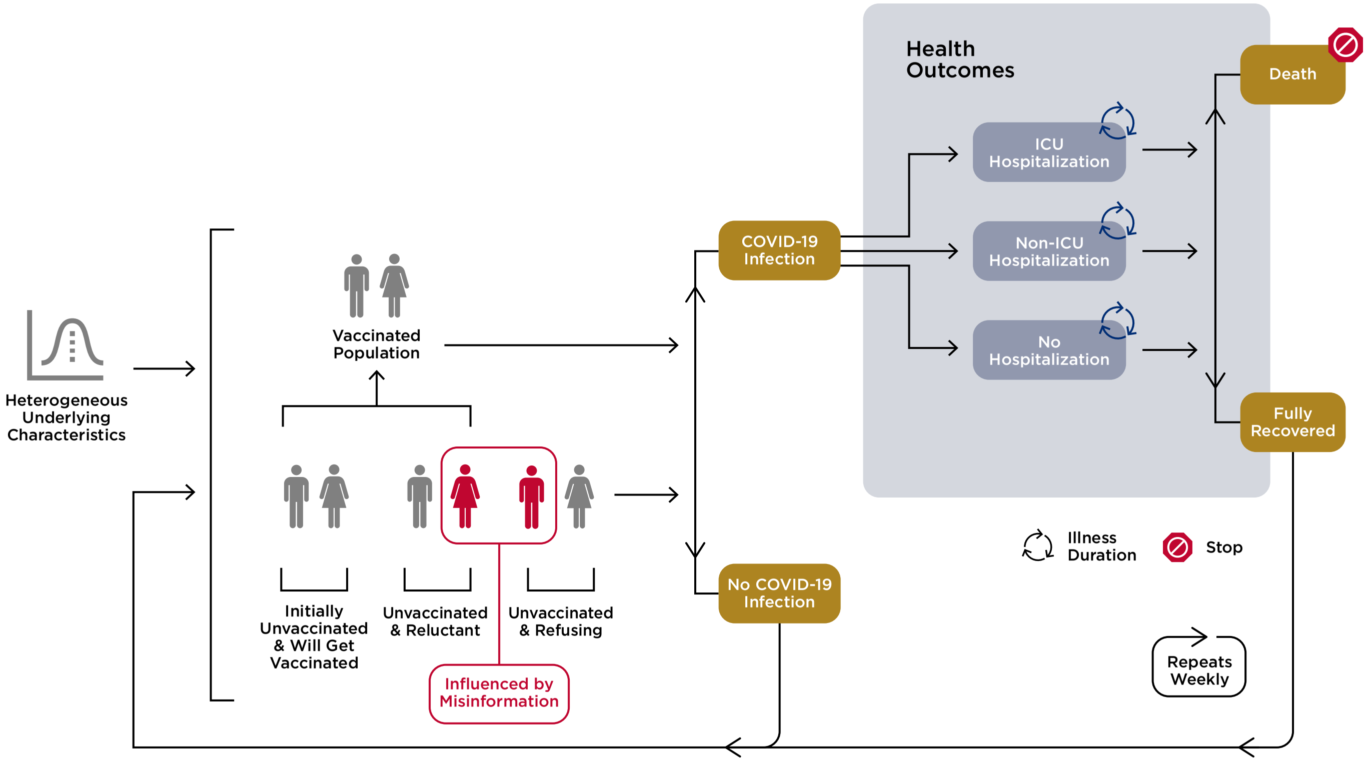

Heterogeneous Underlying Characteristics
Vaccinated Population
Initially Unvaccinated & Will Get Vaccinated
Unvaccinated & Reluctant
Unvaccinated & Refusing
Influenced by Misinformation
COVID-19 Infection
No COVID-19 Infection
Health Outcomes
ICU Hospitalization
Non-ICU Hospitalization
No Hospitalization
Death
Fully Recovered
Illness Duration
Stop
Repeats Weekly

Figure 4.1 Agent-Based Model Flow Diagram

The model is populated with hypothetical agents with heterogeneous underlying characteristics. The agents are divided among unvaccinated and vaccinated groups. Agents can either be infected or not; if they are infected, they can then recover at home, be hospitalized, or be admitted to an ICU. Ultimately, these agents will fully recover or die. The probability of these infections and outcomes varies with vaccination status.

Three hypothetical model scenarios were simulated to describe what vaccination rates would have looked like if the influence of misinformation were reduced, meaning more agents accepted vaccination. The Abacus Data source summarized in Table 4.1 was used to estimate the share of the vaccine-hesitant population with specific misinformed beliefs. These data were chosen because they offer two different versions of beliefs in misinformation, providing a range of possible impacts of misinformation on COVID-19 vaccination rates in Canada. Box 4.1 describes other corroborating data. The first estimate of the level of misinformation in the population was based on the proportion of survey participants who agreed that COVID-19 is a hoax or exaggerated. The second estimate was based on the proportion who agreed that vaccines cause many problems that are covered up. The Panel assumed these distinct beliefs among vaccine-hesitant populations could be the result of different lines of misinformation about COVID-19.

Table 4.1 Misinformation Beliefs Among Vaccine-Reluctant and Vaccine-Refusing Populations

		Population Segment Who Are	
		Vaccine-Reluctant	**Vaccine-Refusing**
Percent of the Population Number of people in Canada (millions)		**7%** (2.1)	**7%** (2.1)
Percent (of 2.1 million) who agree with the statement	**COVID-19 is a Hoax/Exaggerated**	**34%**	**73%**
	Vaccines Cause Many Covered-Up Problems	**66%**	**85%**

Data Source: Abacus Data (2021), as cited in Anderson (2021)

Box 4.1 Canadian Data on Vaccine Hesitancy and Misinformation

Several Canadian public opinion surveys have explored misinformation and COVID-19 vaccine hesitancy (e.g., Angus Reid Institute, 2021; EKOS, 2021). The Panel chose to use the Abacus Data source summarized in Table 4.1 because it readily mapped beliefs in misinformation to vaccine hesitancy. Other Canadian surveys show broadly similar patterns, with the Angus Reid Institute (2021) reporting that, among unvaccinated people, 90% think COVID-19 health risks are overstated, while the majority think COVID-19 is a conspiracy linked to government control. EKOS (2021) reports that 16% of respondents to one survey believe the severity of the pandemic is exaggerated.

Recognizing the complexity of hesitancy and misinformation, the Panel used these data to construct three hypothetical scenarios:

(i) **No Hoax:** The belief that COVID-19 is a hoax/exaggerated was eliminated and all those who reported this belief in the baseline model were assumed to be vaccine-accepting in this scenario.

(ii) **No Cover-Up:** The belief that vaccine harms are being hidden was eliminated and all those who reported this belief in the baseline model were assumed to be vaccine-accepting in this scenario.

(iii) **Full Vaccine Acceptance:** The entire population was assumed to be vaccine-accepting in this scenario.

First, the baseline model was simulated, aligning with Canadian real-world data. Then, the three hypothetical scenarios were simulated, within which more agents were willing to be vaccinated. The increased amount of population simulated as willing to vaccinate in the No Hoax and No Cover-Up scenarios are described in Table 4.1. All reluctant and refusing populations were simulated to be vaccinated in the Full Vaccine Acceptance scenario. To calculate the impact of misinformation, baseline model results were subtracted from the results of each scenario in terms of number of vaccinations, cases, hospitalizations, ICU visits, deaths, and costs.

In the Panel's view, the No Hoax and No Cover-Up misinformation scenarios represent the elimination of two sources of unambiguous and severe instances of misinformation. In contrast, the Full Vaccine Acceptance scenario presents an upper bound of what the outcomes might be if all people accepted vaccination as soon as a vaccine was available. This upper bound helps to benchmark and interpret the results of the two misinformation scenarios. The three model scenarios offer a range of the extent to which the Canadian population was misinformed about COVID-19 vaccines in 2021.

By comparing the baseline and hypothetical scenarios, it is possible to estimate the differences in health outcomes between scenarios, producing a share of the population for whom misinformation is a contributing factor to the choice not to vaccinate. The model assumes a causal relationship between misinformed beliefs and vaccine hesitancy based on the established literature reviewed in Section 4.1.

4.2.3 Model Time Periods

Vaccine supply was limited in Canada between March and June 2021, when vaccination policies dictated that only first doses be administered (Skowronski *et al.*, 2021). Supply was no longer a constraint by mid-July, but vaccine hesitancy stalled progress in further increasing overall vaccination coverage (Aiello, 2021a, 2021b). To capture these distinct periods, the model separated out first dose and full vaccination (two doses). The first half of the model focused on administration of the first vaccine dose. This is because the long delays in administration of a second dose were due to policy rather than hesitancy. Available supply in that period was estimated based on available but unused appointment slots offered to the 70+ population (Table A1.2 in Appendix A). In the second half of the model, vaccination supply was opened up. In the hypothetical scenarios, more people chose to be vaccinated and there was adequate supply to accommodate them. The maximum number of agents hypothetically vaccinated during this period never exceeded the highest week of real-world vaccinations given per province or territory. Vaccinations were administered by age group in the model, starting with the oldest age groups and moving to the youngest.

4.3 Health Impacts

Unvaccinated people are more likely to contract COVID-19, develop more severe symptoms, require hospitalization, and die. National data collected during the period of July 25 to August 21, 2021 showed that unvaccinated people were 12 times as likely to contract COVID-19 and 36 times as likely to be hospitalized (PHAC, 2021b). Similarly, Canadian data up to January 8, 2022 showed that "fully vaccinated individuals diagnosed with COVID-19 were significantly protected from severe outcomes" (GC, 2022). Among those who did contract COVID-19, people who were unvaccinated were roughly five times as likely to require hospitalization and three times as likely to die compared to those who were fully vaccinated (GC, 2022).

Misinformation contributed to lower vaccination rates and delays in vaccination

Figure 4.2 presents the share of people aged 12 and over who were vaccinated in Canada in the baseline model and across the scenarios. The close overlay between the baseline and real-world data illustrates the degree of alignment between the model and observed data. The areas between each hypothetical scenario and the baseline model illustrate the impact of misinformation on COVID-19 vaccine hesitancy. Between March and mid-July 2021, the model simulated administration of first doses. All the hypothetical scenarios are identical in that early stage because there were still unvaccinated but willing-to-vaccinate individuals across all scenarios. As vaccines became readily available by mid-July, the model then focused on those who were fully vaccinated. The difference between the baseline and the hypothetical scenarios reflects greater willingness to both vaccinate and vaccinate earlier.

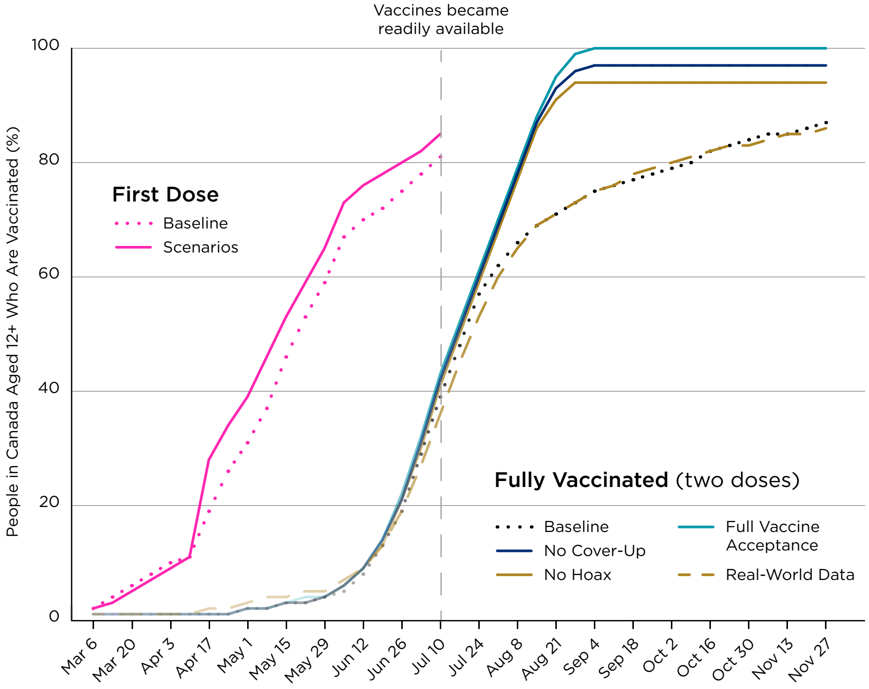


Figure 4.2 COVID-19 Vaccination Coverage in Canada, 2021

Vaccination coverage over time among individuals aged 12 and over across baseline and three model scenarios. The areas between the No Hoax and No Cover-Up scenarios and the baseline model illustrate the impact of misinformation on COVID-19 vaccine hesitancy. The left side of the graph shows the early time period when vaccine supply was limited, and the first dose is modelled. The right side shows the later time period when vaccine supply was no longer constrained, and full vaccination (two doses) is modelled.

Misinformation contributed to increases of at least 22–35% in COVID-19 caseload, morbidity, and mortality, particularly during the autumn 2021 wave

People who held misinformed beliefs about vaccines and the pandemic were less likely to be vaccinated and vaccinate early. Subsequently, they were more likely to become infected, require hospitalization, and die from COVID-19. Figure 4.3 shows all-age COVID-19 cases in Canada between March 1 and November 30, 2021, including reported cases, estimates from the baseline model, and simulated cases across the three scenarios. The hypothetical scenarios, where the influence of misinformation is removed, show a relatively small reduction in the number of new cases in the first peak (i.e., the spring 2021 wave of the pandemic) and a much larger decline in cases in the second peak (i.e., fall 2021 wave). The decrease in COVID-19 cases is driven by higher vaccination rates in the three scenarios as compared to the baseline, because the incidence of COVID-19 is lower among people who are vaccinated compared to people who are unvaccinated.

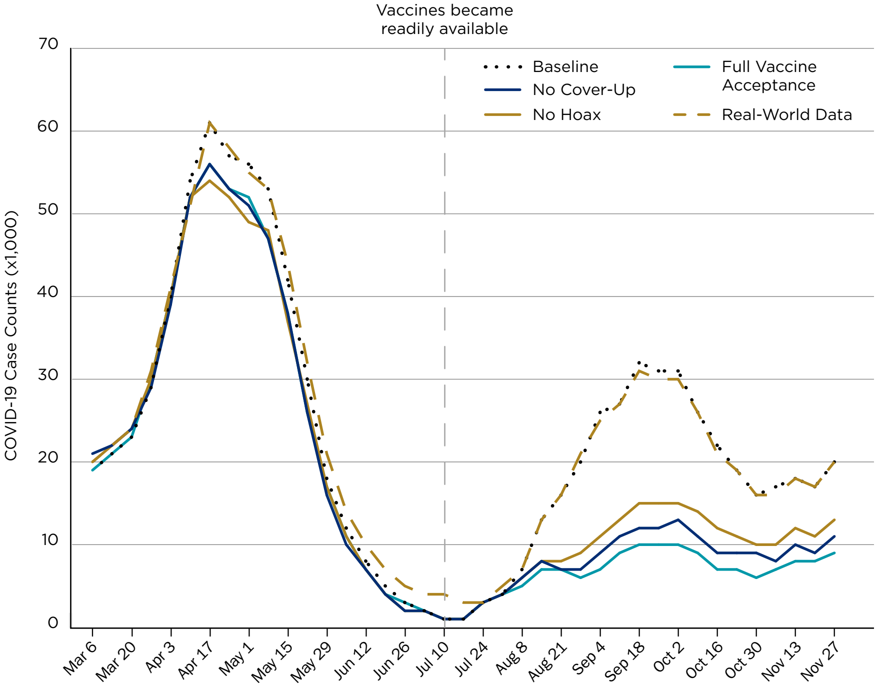


Figure 4.3 COVID-19 Cases in Canada, 2021

Number of cases over time across baseline and three model scenarios. The areas between the No Hoax and No Cover-Up scenarios and the baseline model illustrate the impact of misinformation on COVID-19 cases. The difference in COVID-19 cases is more pronounced during the autumn period when vaccine supply was no longer restricted.

These lower case counts lead, in turn, to lower hospitalization levels and mortality; Table 4.2 presents the average results. Hospitalization estimates are inclusive of ICU patients. Compared to baseline results, all three scenarios increased vaccinations by at least 8% (over 2.3 million people) and reduced COVID-19 cases by at least 22% (over 198,000 cases), hospitalizations by at least 28% (over 13,000 hospitalizations), deaths by at least 35% (over 2,800 deaths), and life years lost by at least 34% (over 45,000 years of life) between March 1 and November 30, 2021. In sensitivity analyses, results were within roughly 10% of the mean (see Appendix A5.5).

Table 4.2 Estimated Impact of Misinformation

	Vaccinated	Cases	Hospitalizations	ICU Admissions	Deaths	Years of Life Lost
Baseline Number	**29,157,000**	915,000	46,000	11,000	7,900	133,000
Total Number	**Increase (%) ↑**	**Decrease (%) ↓**				
No Hoax	**2,350,000 (8%)**	198,000 (22%)	13,000 (28%)	3,500 (30%)	2,800 (35%)	45,000 (34%)
No Cover-Up	**3,233,000 (11%)**	230,000 (25%)	16,000 (35%)	4,300 (38%)	2,900 (37%)	50,000 (38%)
Full Vaccine Acceptance	**4,328,000 (15%)**	263,000 (29%)	18,000 (39%)	4,800 (42%)	3,000 (38%)	53,000 (40%)

Much of the harm associated with misinformation can be attributed to vaccination delay

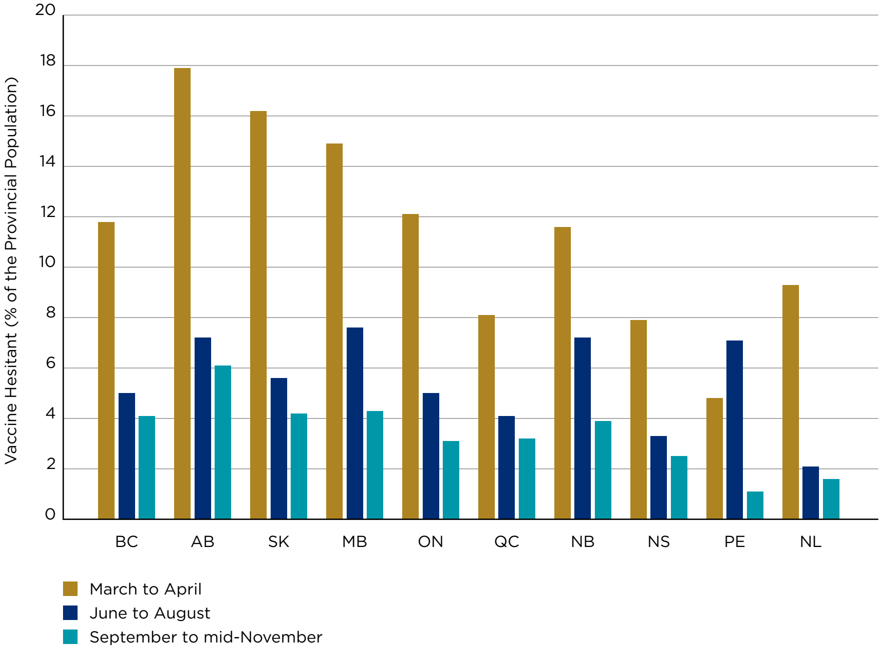
The No Hoax scenario represents a relatively small increase in people who are fully vaccinated that led to an outsized reduction in cases. This can be attributed, in large part, to the differences in the timing of vaccination between the baseline and hypothetical scenarios. Although limited *additional* doses were administered during the model period, many doses were administered *a lot earlier* in the hypothetical scenarios. The total increase in vaccination coverage in later months did not have as much effect on cases, hospitalizations, and deaths as vaccinating earlier did. Prioritizing older adults for earlier vaccination had an outsized impact on cases, hospitalizations, and deaths. In the hypothetical scenarios, where hesitancy was removed, the older and most at-risk people were already vaccinated before the autumn 2021 wave hit.

Addressing misinformation is important across age groups

Older adults remaining unvaccinated due to misinformation results disproportionately in higher hospitalizations, deaths, and costs due to their increased likelihood of experiencing severe health effects compared to younger people. However, older adults in Canada accepted vaccinations at higher rates than younger people. The model simulations indicate that the impacts of removing misinformation from older and younger age groups have comparable benefits in aggregate due to the difference in population size.

The burden of COVID-19 varies across provinces, in line with rates of vaccine hesitancy

Surveys conducted by Statistics Canada show meaningful variation in vaccine hesitancy across the provinces (Figure 4.4). Across Canada, willingness to vaccinate increased over time. However, there was greater vaccine hesitancy — particularly in the Prairie provinces — during the spring of 2021.



Data Source: StatCan (2022b)

Figure 4.4 Vaccine Hesitancy by Province, 2021

Share of the provincial population that reported being unlikely to get a COVID-19 vaccine, between March and mid-November 2021. Data from the territories were unavailable.

The number of vaccinations reported by province, together with the timing of these vaccinations, is a function of misinformation and other factors, including vaccine supply, age structure of the population (which influences the timing of vaccine eligibility), and willingness to vaccinate (which itself varies by age and province). Because of these complexities and the use of national-level model inputs for misinformation beliefs, the results are presented only at the national level.

4.4 Economic Impacts

Hospitalizations and ICU visits led to healthcare system costs. These results provide only a partial estimate of the costs associated with COVID-19 misinformation, since they do not consider physician billing, outpatient costs, time away from work, costs of treating long COVID, productivity losses from premature deaths, or wider societal costs.

Unvaccinated people who believe COVID-19 is a hoax or exaggerated added roughly $300 million to hospitalization and ICU costs in Canada

The Canadian Institute for Health Information (CIHI) estimates the average cost of a COVID-19 hospitalization in Canada to be more than $13,000, and this figure rises to more than $55,000 when patients require an ICU stay (CIHI, 2022). All told, the model estimated that, of the $1,035 million in COVID-19 hospitalization and ICU costs, removing the impact of misinformation would have saved approximately $299 million in the No Hoax scenario and $372 million in the No Cover-Up scenario due to averted hospitalizations and ICU stays between March and November 2021 (Figure 4.5). If everyone aged 12 and over in Canada had become vaccinated as soon as they were given the opportunity, $387 million in costs would have been saved. In sensitivity analysis, results ranged by less than $20 million above and below the mean (see Appendix A5.5). Though national cost estimates help elucidate the collective cost of misinformation, the Panel stresses unequivocally that these numbers ignore the profound and deeply problematic fact that many groups faced far worse impacts during the pandemic than others (Section 4.6.1).

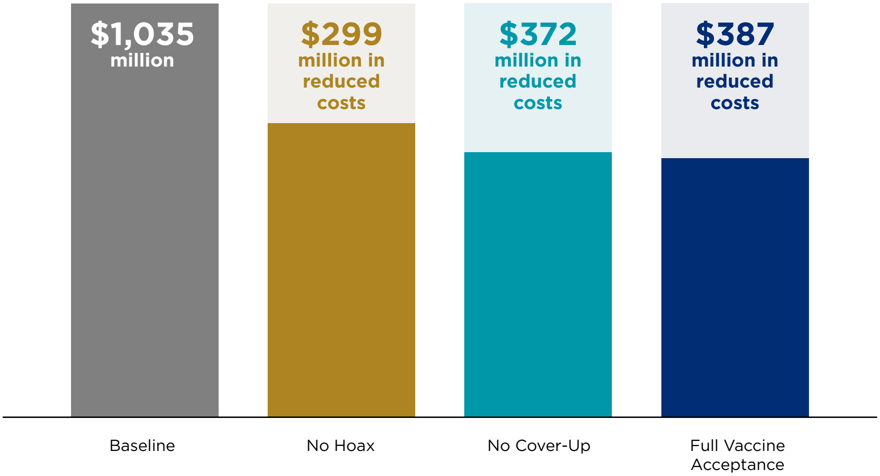


Figure 4.5 Savings in Hospitalization and ICU Costs

Hospitalization and ICU costs are estimated at $1,035 million in the baseline level but fall substantially in the hypothetical scenarios.

4.5 Model Limitations

The model only provides a fraction of the total costs of COVID-19 due to data limitations:

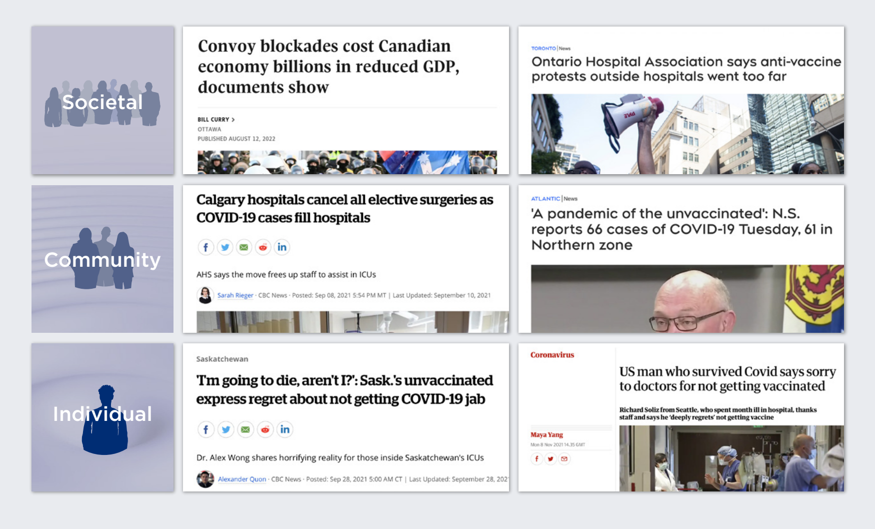
- Cases, hospitalizations, and deaths are likely underreported (Moriarty *et al.*, 2021; StatCan, 2022c).
- Other direct health costs, including outpatient medication, physician compensation, and long COVID costs, were not available at an appropriate quality or resolution to be included in the analysis.
- Quality of life impacts associated with COVID-19 illness (including long COVID) are excluded from these estimates.
- Wider societal costs, including those associated with delayed elective surgeries and other healthcare services, lost wages, and productivity declines, were not available in a way that could be reliably incorporated into the model.

The Panel's model assumed the same weekly incidence of COVID-19 for vaccinated populations across the baseline model and the three scenarios. Similarly, the model assumed the same weekly incidence of COVID-19 for unvaccinated populations across the baseline model and the three scenarios. This means that, for the same week, unvaccinated people had the same likelihood of becoming ill from COVID-19 across the baseline model and three scenarios (as did vaccinated people, at a lower level). This assumption that disease incidence among vaccinated and unvaccinated people is unchanged across scenarios further reinforces the model's conservativeness, as the incidence rate would be expected to fall if vaccination were to increase. The model is built from observed epidemiological data, which capture all the underlying dynamics that played out in Canada between March and November 2021 (e.g., masking, social distancing, lockdowns, resistance, personal behaviour). The Panel's model is not a transmission model, so it is not possible to isolate the impact of vaccination in reducing COVID-19 cases from other public health measures and individual behaviours.

Due to a lack of data, it was not possible to analyze misinformation's contribution to the costs of vaccine hesitancy among specific demographic groups. The lack of collection and open dissemination of these data obscures problems of inequity and risks amplifying equity issues by failing to identify the unequal burden faced by racialized and other minoritized people.

4.6 Broader Socioeconomic Impacts of COVID-19 Misinformation

The health and hospitalization costs presented above provide a partial view of the harms associated with misinformation. The model results do not provide information about the effects of racialization, socioeconomic status, comorbidity, occupation, multi-person residences, geography, or other potentially important factors contributing to the impacts of misinformation. This section explores some of these dimensions based on other analyses. Additionally, beyond the individual health consequences and hospitalization costs described above, delays and avoidance of vaccination have prolonged and intensified the pandemic, with harms radiating outwards through communities and the economy (Figure 4.6).



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Sarah Rieger · CBC News · Posted: Sep 08, 2021 5:54 PM MT | Last Updated: September 10, 2021

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Saskatchewan
'I'm going to die, aren't I?': Sask.'s unvaccinated express regret about not getting COVID-19 jab

Dr. Alex Wong shares horrifying reality for those inside Saskatchewan's ICUs

Alexander Quon · CBC News · Posted: Sep 28, 2021 5:00 AM CT | Last Updated: September 28, 202

Coronavirus
US man who survived Covid says sorry to doctors for not getting vaccinated

Richard Soliz from Seattle, who spent month ill in hospital, thanks staff and says he 'deeply regrets' not getting vaccine

Maya Yang
Mon 8 Nov 2021 14.35 GMT

Figure 4.6 COVID-19 Misinformation Harms Across Scales

The harms of COVID-19 misinformation are first incurred at the individual level with increased morbidity and mortality. These harms then radiate outwards with impacts felt at the community level (e.g., by placing additional demands on scarce healthcare resources). Ultimately, all of society feels the impacts of the misinformation when it contributes to social unrest.

4.6.1 Societal Impacts

One's choice to delay or refuse vaccination can have consequences for other people and for society as a whole. Contact with people who are unvaccinated increases the risk of infection among those who are vaccinated (Baker & Robinson, 2021; Fisman *et al.*, 2022). Beyond the persistent risk of infection, "an unvaccinated pool of individuals provides a reservoir for the virus to continue to grow and multiply, and therefore more opportunities for … variants to emerge" (Goldman, 2021). These variants may escape the immunity conferred by existing vaccines, creating new risks for both people who are vaccinated and people who are unvaccinated (Goldman, 2021).

The consequences of vaccine misinformation ripple across society

Surging COVID-19 cases, largely in unvaccinated patients, burdened hospitals in western Canada in autumn 2021 (Gov. of AB, 2022). This led to delays in elective surgeries, with profound impacts on those awaiting potentially life-changing interventions (Keller *et al.*, 2021). Interventions that qualified as elective and were thus put on hold included corrective eye surgery for a one-year-old child (who was increasingly likely to have permanent vision problems as the surgery was delayed) and surgery to alleviate pain and unreliable motor skills for a 35-year-old person with brain cancer (Keller *et al.*, 2021).

In addition to carrying out their duties amid the stresses of a pandemic, healthcare professionals faced protests fuelled by misinformation, with reports of blocked hospital access, verbal altercations, and even death threats (Fox, 2021; Miller, 2021; Russell & Bell, 2021). People affected by the protests described them as "demoralizing," "deeply distressing," and "almost soul breaking" (Bains, 2021; Praill, 2021). The additional work of trying to respond to patients who refused the vaccine based on misinformation and rejection of science frustrated many doctors and nurses, and strained compassion (Karkowsky, 2021). Healthcare professionals can also experience moral injury when they are unable to provide important care to their patients due to an overstretched system and vaccine hesitancy (Dean *et al.*, 2019; Peitso, 2022).

The costs of misinformation are borne unevenly across society owing to long-standing health and socioeconomic inequities

COVID-19 has highlighted and exacerbated existing inequity in Canadian society. Data from Toronto show that people from Black, Latin American, South and Southeast Asian, Indo-Caribbean, Arab, Middle Eastern, and West Asian communities experienced disproportionately high rates of COVID-19 infection and hospitalization compared to the population as a whole, even when controlling for age (City of Toronto, 2022). An Ontario-wide analysis found that racialized people were 1.2–7.1 times more likely to be infected than non-racialized people, and 1.7–7.6 times more likely to die from infection (Wellesley Institute and Ontario Health, 2021). As the Government of Ontario deployed COVID-19 vaccines across the province, pharmacies in the 10 Toronto neighbourhoods with the highest rates of COVID-19 were half as likely to offer vaccines as those in the 10 neighbourhoods with the lowest rates of COVID-19 (Ouellet & McMillan, 2022). According to the Wellesley Institute and Ontario Health (2021), "the inequitable outcomes throughout the pandemic highlight the ongoing need to take an anti-racist approach to address the structural racism embedded in the delivery of health care." Consistent with the City of Toronto findings, the Wellesley Institute and Ontario Health (2021) also found elevated rates of infection, hospitalization, and death among all racial groupings except for people of East Asian and European descent. Socioeconomic factors contributing to elevated rates of COVID-19 among racialized groups include overrepresentation in frontline employment sectors and the challenges of isolating within crowded living situations (Grant, 2020; Mensah & Williams, 2022). Misinformation — as a contributor to lower vaccination rates — can have disproportionately high impacts on racialized communities.

The impacts of a pandemic prolonged, in part, by misinformation and vaccine hesitancy can disproportionately affect some communities. For example, Indigenous people have reported greater financial strains and worse mental health than other people in Canada during the pandemic (Arriagada *et al.*, 2020; Fallding, 2021). Structural inequities in Indigenous communities, including a lack of broadband internet access and infrastructure, affordable and safe housing, and access to clean water, employment opportunities, healthcare, and mental health services, among others, were further exacerbated by the pandemic (Mashford-Pringle *et al.*, 2021). For instance, physical distancing guidelines were challenging to follow because of overcrowded housing conditions. As in other communities, physical distancing guidelines also undermined participation in cultural practices, which in turn negatively influenced mental and emotional well-being. A lack of public health infrastructure undermined community pandemic response in some situations (Mashford-Pringle *et al.*, 2021). Adverse impacts of the pandemic were measurably worse for many Indigenous communities, particularly with respect to economic well-being and mental health (StatCan, 2021a).

Misinformation targeting marginalized and racialized groups has been prevalent throughout the pandemic

There are instances of misinformation targeting specific communities and even pointing to past failings of the medical system to stoke fears of vaccines (Griffith *et al.*, 2021; Zadrozny & Adams, 2021). For example, as noted in Section 2.1.3, a film by the anti-vaccine organization Children's Health Defense claims that COVID-19 vaccines are being used to experiment on Black communities, evoking historical abuses as proof (Zadrozny & Adams, 2021). Fictional claims about Black immunity also circulated early in the pandemic (Ross, 2020). Other misinformation has targeted Muslim communities, such as false claims about the presence of pork and alcohol in the vaccines (Chowdhury, 2021).

Researchers have also observed that misinformation expressed in languages other than English is less likely to be flagged or removed by Facebook, placing those language speakers at greater risk of exposure to misinformation and potentially exacerbating pre-existing health inequities (Iyengar, 2021; Paul, 2021). For example, it can take Facebook days longer to flag Spanish-language vaccine misinformation posts compared to English posts, if they are flagged at all (Gamboa, 2021). Analyses from Europe suggest that Italian-, Portuguese-, and French-language content is subject to even less scrutiny (Avaaz, 2021).

4.6.2 Economic Impacts

The economic impacts of COVID-19 misinformation on vaccine hesitancy extend beyond the immediate hospitalization costs described in Section 4.4. These include, for example, the impacts of long COVID, time spent in hospital, time spent caring for a sick relative, and decreased economic activity, such as through the decreased consumption of goods and services, which ultimately impacts GDP.

Long COVID results in substantial personal and economic costs

Vaccination appears to reduce the incidence of long COVID (i.e., the persistence of one or more COVID-19 symptoms months after infection) (Zisis *et al.*, 2022). Long COVID is having substantial impacts on the economic welfare and quality of life of people in Canada. Wong *et al.* (2020) found that, of 78 patients admitted to hospital with COVID-19 in Vancouver, 76% reported one or more abnormal patient-reported outcome measures — on quality of life, frailty, dyspnea (shortness of breath), mood, or sleep — three months after they were discharged. A systematic review of studies published between January 1, 2020 and March 11, 2021 found 72.5% of people with COVID-19 (most of whom were hospitalized) reported at least one persistent symptom (Nasserie *et al.*, 2021). Taquet *et al.* (2021) found that 37% of COVID-19 survivors[15] had at least one long-COVID symptom three to six months after diagnosis, including fatigue, breathing issues, and chest pain, as well as pain or cognitive and mood changes (e.g., anxiety, depression).

There is increasing evidence of a decline in cognitive function following hospitalization from COVID-19 infection (Hellgren *et al.*, 2021; Park *et al.*, 2021). One study from the United Kingdom found that, even among milder cases (i.e., not hospitalized), COVID-19 infection can result in brain changes and negatively impact brain function among older adults (51 to 81 years old) (Douaud *et al.*, 2022). The impaired or reduced cognitive and physical function experienced by those with long COVID can limit routine daily activities (e.g., dressing and feeding oneself) or reduce one's ability to care for dependents or older family members (reviewed in Razak *et al.*, 2021). Approximately 10% of people with long COVID have said they have been unable to return to work in the long term (GC, 2021d). People with long COVID often required additional medical visits — about half made five or more additional clinic visits (VINEx *et al.*, 2021). Lost wages, healthcare costs, and costs of disability insurance resulting from claims due to long COVID all add to the financial toll (VINEx *et al.*, 2021).

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[15] Note that these were COVID-19 patients identified through the electronic health records of U.S. healthcare organizations (i.e., hospitals, primary care, and specialist providers), and thus do not include people who did not seek or receive medical attention when experiencing long-COVID symptoms.

Misinformation that delays vaccine adoption will slow the Canadian economy

The COVID-19 pandemic has imposed economic harms through reduced consumption of goods and services, financial market shocks, and supply-side disruptions (Brodeur *et al.*, 2021). Castillo *et al.* (2021) present US$1 trillion as a "conservative measure of comprehensive global monthly harm" associated with COVID-19. As the pandemic persists, all members of society experience a wider set of associated economic harms (Castillo *et al.*, 2021). Loss of employment and reduction in work hours disproportionately harmed lower-income earners and racialized people (Lemieux *et al.*, 2020; StatCan, 2022d).

The enduring burden of COVID-19 may create acute, ongoing economic losses if a significant proportion of the global population remains unvaccinated (Hafner *et al.*, 2020). The interconnectedness of world economies and global disease spread means the economic effects of unvaccinated and under-vaccinated communities are not geographically confined. The Access to COVID-19 Tools Accelerator (ACT-A) program was established and is being funded partially in recognition of the global benefits of confronting COVID-19 in developing countries (ACT-A, 2021). ACT-A (2021) projects that the full implementation of this program could mitigate US$5.3 trillion in global economic losses over a five-year period and reduce the risks of the emergence of new variants of concern. A declaration launched at the United Nations General Assembly in support of equitable global access to COVID-19 vaccines (including support for ACT-A) identified misinformation as a critical challenge to the success of a global inoculation campaign (UNGA President, 2021).

Consistent with the Panel's results presented above, economic modelling demonstrates that vaccinations are important for recovery and that the earlier they are administered, the greater the economic benefit (Gros & Gros, 2021). The benefits of vaccination were sufficient to warrant incentivizing production early in the pandemic to avert economic losses. An analysis of the economics associated with incentivizing vaccine production showed the GDP savings to be 4–5%, or US$2,600 to $3,000, per vaccinated person in the United States; these savings would be greater still with a full-income approach that considers the value of lives lost (Gros & Gros, 2021). In another U.S. study, a doubling of vaccine doses — from 1.5 to 3 million per day (as of March 2021) — was predicted to provide near-term economic benefits, including a roughly 1% boost to GDP and a boost to employment by over two million jobs over the course of the summer of 2021 (VINEx *et al.*, 2021). Canadian modelling estimated the costs of a one-month delay in vaccine deployment at $7 to $16 billion of GDP, corresponding to 62,000 to 116,000 additional annual full-time jobs (Cotton *et al.*, 2021).

5

The Message and Medium of Misinformation, and its Response

5.1 Susceptibility to Misinformation

5.2 Successfully Countering Information

Chapter Findings

- Misinformation is increasingly tailored to make it more appealing, generally by exploiting the vulnerabilities of target audiences.
- Our modern media environment continually exposes us to misinformation, which impairs our ability to detect and increases our susceptibility to misinformation.
- Many preventative and corrective techniques help limit the spread of and belief in misinformation, but none alone is sufficient to eliminate its effects.
- A combination of techniques that help us recognize misinformation, improve our understanding of how it affects us, and provide us with accurate information — effectively communicated in the appropriate medium and from a trusted messenger — is necessary to meet the magnitude of the challenge.

5.1 Susceptibility to Misinformation

The combination of misinformation's increasing ubiquity and our own vulnerability makes the risk of absorbing science and health misinformation endemic (Pennycook *et al.*, 2020a; Loomba *et al.*, 2021). Exposure to misinformation, alone, can make us more likely to believe and remember it (Begg *et al.*, 1992; Pennycook *et al.*, 2018). Higher levels of exposure can make it easier for us to process a claim and prompt us to think it is widely held (therefore we perceive it as true) (Begg *et al.*, 1992; Buchanan, 2020; Innes *et al.*, 2021). Misinformation exposure is a function of personal online behaviours and our information environment, but it can be manipulated by, for example, social media bots and algorithms (Shao *et al.*, 2018; Global Witness, 2022). The use of bots is particularly concerning given that repetition alone can alter the visibility of a message to the point where "a repetitive voice can sound like a chorus" (Weaver *et al.*, 2007).

However pervasive, not all misinformation translates into belief or action. A wide variety of factors — the characteristics of the information environment, the message, the messenger, the receiver, and the medium — play a role in determining the influence and impact of science and health misinformation. How content is communicated and circulated can influence the likelihood of our believing and sharing a claim. However, our relative susceptibility to believing and spreading misinformation, and its impact on our subsequent actions, is variable. What is invariable is that everyone is, to some extent, vulnerable to misinformation, regardless of age, education, socioeconomic status, psychology, or personality.

5.1.1 Characteristics of the Message and Medium

The subject of a message, in part, determines how it is shared and spread. For example, political misinformation on Twitter spreads faster than science misinformation, but science misinformation spreads to a broader audience (Vosoughi *et al.*, 2018). Content and presentation also determine the potency of a message. A message's influence reflects the language used and the topic presented combined with aspects of the presentation, such as the appearance of credibility. Thus, the language, construction, and context of the message will impact the likelihood of it being believed and shared (Table 5.1).

Table 5.1 Misinformation Message Characteristics That Increase Influence

Characteristic	Reference
Repetitive and simple, providing a clear and unambiguous explanation	Lombrozo (2007); Rapp and Kendeou (2007); Horne and Adali (2017); Marchlewska *et al.* (2018); Hejniak *et al.* (2019)
Designed to evoke emotions, particularly anger, disgust, and surprise	Bodenhausen *et al.* (1994); MacKuen *et al.* (2010); Koch and Forgas (2012); Weeks (2015); Vosoughi *et al.* (2018); Forgas (2019)
Appears to be from a trusted, credible source	Buchanan and Benson (2019); Buchanan (2020); Pennycook *et al.* (2021)

Simple, emotive, and explanatory misinformation is persuasive

Effective misinformation messages are often repetitive, simple, and designed to evoke emotion (Horne & Adali, 2017). They are more apt to be believed when they provide cognitive closure by eliminating ambiguity and purporting to provide definite conclusions (Marchlewska *et al.*, 2018; Hejniak *et al.*, 2019). Conspiracy theories, for instance, feed our desire for certainty by decreasing real-world complexity (Webster & Kruglanski, 1997; Bessi *et al.*, 2015b). They claim to explain important, often frightening, events such as wars, acts of terrorism, and disease outbreaks, often by providing a target to blame (van Prooijen & van Dijk, 2014; Goreis & Voracek, 2019). If the misinformation sets out a clear and simple causal relationship, one that helps explain a course of events, it is more likely to be remembered and harder to correct (Rapp & Kendeou, 2007). For example, dissuading a person with the misinformed belief that vaccines cause autism is challenging because there is no well-understood cause of autism to fill that mental gap (Sangalang *et al.*, 2019).

Negative sentiments such as anger, fear, and outrage correlate with engagement on social media, which increases the virality of misinformation and leads to greater exposure (Zollo *et al.*, 2015). Misinformation encountered on Twitter more frequently elicits surprise and disgust, whereas correct information inspires feelings of trust, sadness, and anticipation (Vosoughi *et al.*, 2018). On Facebook, the longer a discussion continues on a given topic, including misinformation, the more negative it becomes, suggesting that such conversations feed negative sentiments (Zollo *et al.*, 2015). As an example, messaging used to spread misinformation about the health effects of fluoride in drinking water manipulated and simplified the scientific evidence, but also appealed to emotions of fear and outrage by linking fluoride to unfounded claims of harm to children (Armfield, 2007). Similarly, negative moral-emotional language (i.e., using words that appeal to both negative emotions and morals) predicted higher rates of retweets among 400,000 tweets related to climate change between October 30 and November 24, 2015 (Brady *et al.*, 2017).

Imitating or manipulating trusted sources is an effective way to spread misinformation

Though our motivations for sharing misinformation are complex (e.g., social interaction, partisanship, accuracy, perceived utility, sowing chaos), the proportion of those who appear to share misinformation with the deliberate intent to mislead others is between 4% and 20% (Petersen *et al.*, 2018; Van Bavel & Pereira, 2018; Altay *et al.*, 2021; Pennycook *et al.*, 2021). We do not always spend the time necessary to verify information's accuracy, and those who are less astute at judging the credibility of sources are also more likely to believe and share misinformation (Nikolov *et al.*, 2021; Pehlivanoglu *et al.*, 2021; Pennycook *et al.*, 2021). The impression of credibility can be evoked by:

- constructing a message to imitate reliable information by mimicking news formats and using similar-looking URLs (Molina *et al.*, 2019);
- presenting credentials from disreputable or unaccredited educational or medical institutions as legitimate;
- using predatory journals or pre-print servers to give the impression a claim can be found in a peer-reviewed, published academic paper (Nilsen *et al.*, 2022);
- creating think tanks or institutes with names that imply open-mindedness, protection of the common good, or scientific purpose, but which have an alternative agenda, as documented by their funding sources (Section 2.1.3);
- having valid credentials from reputable institutions but commenting outside the scope of one's education and experience (e.g., Schwarcz, 2022);

- creating imposter social media accounts that appear to belong to celebrities, politicians, or influencers to spread misinformation (Klug, 2022);
- using discredited, disreputable, or retracted scientific publications (recall Box 2.3);
- using trusted institutions such as courts illegitimately, in order to feign validity (Box 5.1).

Box 5.1 Using the Legal System to Add Credibility to Vaccine Misinformation

In the United States, the *National Childhood Vaccine Injury Act* and the related National Vaccine Injury Compensation Program were created to ensure both patient protection and continued vaccine distribution by compensating parents for adverse events (Reiss & Heap, 2018). Anti-vaccination groups, however, have used cases settled through this program as evidence of a causal link between vaccines and autism, counter to the consensus legal understanding of this case law (Reiss & Heap, 2018).

Canadian courts are likewise dragged into legal fights that are fodder for anti-vaccine sentiment and misinformation (Butler, 2020; Gallant, 2021). A lawsuit filed on July 6, 2020 in the Ontario Superior Court by Vaccine Choice Canada (an anti-vaccination advocacy group) and seven individuals challenges COVID-19 public health measures by claiming they violate the *Canadian Charter of Rights and Freedoms* (Butler, 2020). The lawsuit contains misinformation about the impacts of public health measures, rehashes conspiracy theories about vaccines being used for surveillance and the "New (economic) World Order," while laying blame for the "false" pandemic on a conspiracy of "billionaire, corporate oligarchs" (Butler, 2020; Ireland, 2020). These types of lawsuits can be used to attempt to silence medical professionals through intimidation or financial hardship (Butler, 2022; Fine, 2022). Though considered unlikely to succeed, they can act to amplify misinformation (Jeffords, 2019; AFP Canada, 2021); in some cases, judges have allowed misinformation about COVID-19 vaccines to be introduced in court proceedings without supporting evidence, legitimizing science and health misinformation in Canadian courts (Caulfield & Benedetti, 2022). It is important to note, however, that not all vaccine-related lawsuits contain misinformation.

The medium used to spread misinformation influences uptake

Misinformation is spread through many types of media and in many forms. Features of the medium can increase the uptake of misinformation. Social media can offer so much information that it becomes detrimental to the user, overloading them. When we are overloaded with information or under stress, we are more likely to exhibit careless decision-making due to poor processing of information, diminished self-control, and impaired encoding and memory retrieval (Ecker *et al.*, 2011; Vishwanath *et al.*, 2011; Samson & Kostyszyn, 2015). In situations where people are exposed to large quantities of new information, as through social media, cognitive capacity can be overwhelmed. This has been described in the literature as "social media fatigue," which reduces how often we verify sources (Ecker *et al.*, 2011; Sweller, 2011; Maier *et al.*, 2015; Samson & Kostyszyn, 2015; Islam *et al.*, 2020). This fatigue leads to our being more likely to spread unverified health information (Laato *et al.*, 2020).

Narratives or stories are particularly effective means of conveying information because they are persuasive, capture how people process the world, and often appeal to our emotions. In this way, narratives can be powerful tools for science communication (Dahlstrom, 2021). However, narrative's emotive appeal can alter our perception of a source's trustworthiness (reviewed in Caulfield *et al.*, 2019). It is more difficult to identify factual errors within narratives compared to other forms of information, which can contribute to an uncritical acceptance of misinformation (reviewed in Dahlstrom, 2021). Narratives, such as testimonials, are an effective means of spreading misinformation, particularly in the health and wellness space (Caulfield *et al.*, 2019). Reading a personal narrative can decrease our ability to reason scientifically when subsequently provided with a description of research on the same topic (Rodriguez *et al.*, 2016).

Another effective technique is packaging misinformation with visuals. Data suggest the format of misinformation (e.g., text, audio, video) influences its spread and makes it available to different audiences (Sundar *et al.*, 2021; Demuyakor & Opata, 2022). For example, video content is more accessible to those with lower literacy levels (Sundar *et al.*, 2021; Demuyakor & Opata, 2022). Memes are frequent forms of misinformation. Appropriately, the term meme originally described ideas that spread like a virus, but now it is used to describe pieces of digital content, often text and pictures, that are remixed to convey information (Geniole *et al.*, 2022). Memes not only enable the spread of misinformation and influence behaviour but also help form collective identities and promote cultural cohesion (Gal *et al.*, 2015; Wong *et al.*, 2022). Memes containing misinformation reduce our view of objectivity, trustworthiness, trust in sources, and belief in the information (Wong *et al.*, 2022) (Figure 5.1). These effects can elicit an emotional response to the content and convey the impression of reasonable arguments, even if the information is incorrect (Harvey *et al.*, 2019). Memes are particularly effective when they align with one's political beliefs, but they can also change perceptions of credibility among people of opposing views (Dupuis & Williams, 2019; Wong *et al.*, 2022).

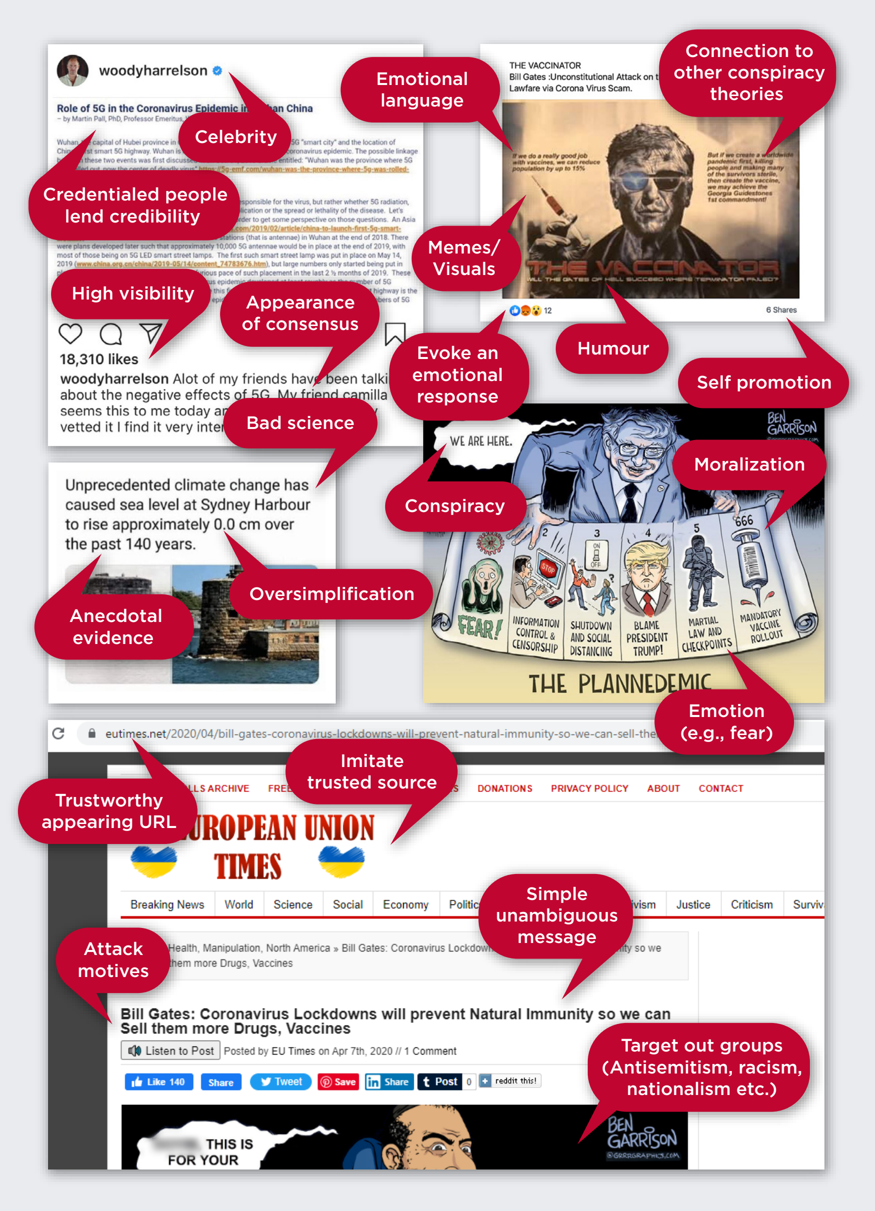
woodyharrelson
Role of 5G in the Coronavirus Epidemic in Wuhan China
Celebrity
Credentialed people lend credibility
Emotional language
Connection to other conspiracy theories
THE VACCINATOR
Bill Gates :Unconstitutional Attack on the Lawfare via Corona Virus Scam.
Memes/ Visuals
THE VACCINATOR
High visibility
Appearance of consensus
18,310 likes
woodyharrelson Alot of my friends have been talking about the negative effects of 5G. My friend camilla seems this to me today and vetted it I find it very interesting
Evoke an emotional response
Humour
Self promotion
6 Shares
Bad science
WE ARE HERE.
Conspiracy
Moralization
FEAR!
INFORMATION CONTROL & CENSORSHIP
SHUTDOWN AND SOCIAL DISTANCING
BLAME PRESIDENT TRUMP!
MARTIAL LAW AND CHECKPOINTS
MANDATORY VACCINE ROLLOUT
666
THE PLANNEDEMIC
BEN GARRISON
Unprecedented climate change has caused sea level at Sydney Harbour to rise approximately 0.0 cm over the past 140 years.
Anecdotal evidence
Oversimplification
Emotion (e.g., fear)
eutimes.net/2020/04/bill-gates-coronavirus-lockdowns-will-prevent-natural-immunity-so-we-can-sell-the
Trustworthy appearing URL
Imitate trusted source
DONATIONS
PRIVACY POLICY
ABOUT
CONTACT
EUROPEAN UNION TIMES
Breaking News
World
Science
Social
Economy
Politics
Justice
Criticism
Simple unambiguous message
Attack motives
Bill Gates: Coronavirus Lockdowns will prevent Natural Immunity so we can Sell them more Drugs, Vaccines
Posted by EU Times on Apr 7th, 2020 // 1 Comment
Target out groups (Antisemitism, racism, nationalism etc.)
THIS IS FOR YOUR
BEN GARRISON

Figure 5.1 Coercive Techniques Found in Misinformation

Misinformation messages use multiple techniques to increase engagement and persuasiveness.

5.1.2 Characteristics of the Receiver

Everyone is vulnerable to misinformation, in part because — unless evidence to the contrary is provided — we assume, by default, that information is accurate and offered in good faith (Schwarz, 1994). Some researchers have even suggested that, in order to understand something even if it is false, one must temporarily accept it as true (Gilbert, 1991). If trusting information is our default state, it may be challenging for anyone to reject misinformation immediately. However, the lasting effect of misinformation (i.e., whether someone continues to believe it and spreads it) depends on various personal characteristics, including prior knowledge and beliefs, age, information processing style, and self-reflectiveness (Table 5.2).

Table 5.2 Receiver Characteristics That Influence Susceptibility to Misinformation

Characteristic	Effect	Reference
Prior knowledge shapes the way we process new information, especially information that contradicts our beliefs		
Motivated reasoning	Conforming new information to pre-existing beliefs	Kahan (2012)
Confirmation bias	Seeking out information that supports what we already believe to be true	Nickerson (1998)
Disconfirmation bias	Being less critical of information that supports our argument and counters opposing opinion	Nickerson (1998); Wolfe and Britt (2008)
Cognitive tendencies influence how we process information		
Analytical thinking	Slow and deliberate thought processes like cognitive reflection, openness, and rational and critical thinking	Hess *et al.* (2012); Toplak *et al.* (2014); Carpenter *et al.* (2018); Tomljenovic and Bubic (2019); Machete and Turpin (2020); Martel *et al.* (2020)
Intuitive thinking	More biased and less discerning fast and intuitive thought processes	de Dreu *et al.* (1999); Pennycook *et al.* (2016); Mosleh *et al.* (2021)

Characteristic	Effect	Reference
Personality traits influence how we interact with information		
Inclination to self-promotion, lack of self-regulation	Increases our likelihood of sharing information we know to be untrue	Buchanan and Benson (2019); Buchanan (2020); Islam *et al.* (2020)
Higher risk-taking behaviour	Increases susceptibility to misinformation and malicious actors	Whittle *et al.* (2013); Baron *et al.* (2015); Koohikamali and Sidorova (2017)
Exposure to misinformation increases the likelihood it is perceived as true		
Familiarity	Increases our perception of consensus and truth, ease of recollection, and efficiency of information processing	Zajonc (1968, 2001); Begg *et al.* (1992); Unkelbach and Greifeneder (2014); Pennycook *et al.* (2018); Buchanan (2020); Innes *et al.* (2021)
Sense of being informed	False perception of being fully informed on a topic when misinformed	Kim *et al.* (2020); Pennycook *et al.* (2020a); Loomba *et al.* (2021)

We are more likely to share information that supports our partisan beliefs and the beliefs of people like us (e.g., shared religion or ethnicity) (Moravec *et al.*, 2019; Guess *et al.*, 2019). We are more likely to underestimate our own biases and overestimate the biases of others (Pronin *et al.*, 2002; Ehrlinger *et al.*, 2005). Moreover, we are more likely to seek out (i.e., confirmation bias) and be less critical of (i.e., disconfirmation bias) information that supports our argument (Nickerson, 1998; Wolfe & Britt, 2008). These biases strengthen our beliefs over time (Taber & Lodge, 2006) and, as a result, we tend to pay more attention to headlines consistent with our political beliefs and spend less time reading (and exhibit more skepticism toward) those that contradict our beliefs (Moravec *et al.*, 2019). Prior beliefs and a lack of accurate self-reflection can act as barriers to correction (Nyhan *et al.*, 2014; Pennycook & Rand, 2019a; Tappin *et al.*, 2020a).

Our biases may be a product of our knowledge and experience rather than ideology (Bago *et al.*, 2020; Tappin *et al.*, 2020b; Pennycook & Rand, 2021). Our prior knowledge and expertise also inform the way we judge science and health claims (Stanford *et al.*, 2002). For example, general consumers depend more on visual design to determine accuracy, whereas experts will depend more on the reputation and source of the claim (Stanford *et al.*, 2002). Our emotions play a vital role in how we process messages. Feelings of urgency bypass the deeper reflections required to detect falsehoods (Vishwanath *et al.*, 2011). Stronger negative emotions have been found to decrease our ability to determine the accuracy of messages, though this effect can be moderated by analytical thinking (Li *et al.*, 2022).

The influence of misinformation is strongest when it is repeated often, is coherent with our worldview, and comes from a presumed credible source (Walter & Tukachinsky, 2020). For example, misinformation claiming that GM plants or animals are not safe to eat is difficult to counter when food companies use the "non-GMO" label as a marketing device (Ben-Shahar, 2017). In Canada, there is no requirement to label foods unless there are health and safety concerns specific to potential allergic reactions, or changes in food composition or nutritional quality (HC, 2020). However, the addition of non-GMO labels to supermarket products has increased the frequency at which we encounter anti-GMO sentiment, reinforcing the sense that disclosure of GM content is relevant to health and safety (given other label information). As Ben-Shahar (2017) argues, "by trying to jazz up their otherwise mediocre and non-descript products through loud campaigns against GMOs, these companies are taking a misperception that pre-existed in the margins and pushing it into the mainstream."

In general, we tend to avoid resource-intensive (i.e., deliberative and analytic) cognitive processes, and this can lead us to uncritically accept misinformation (Kahneman, 2013; Pennycook & Rand, 2019a). Engaging in analytical thinking correlates with resistance to misinformation, helps mitigate one's receptivity to emotional messaging and the partisan effects of misinformation, and contributes to maintaining protective health behaviours (Hess *et al.*, 2012; Pennycook & Rand, 2019a; Tomljenovic & Bubic, 2019; Martel *et al.*, 2020). Analytical thinking is associated with accepting scientific concepts such as evolution, astronomy, geology, mechanics, perception, and thermodynamics (Shtulman & McCallum, 2014; Gervais, 2015). Conversely, people who are more likely to evaluate evidence using an intuitive approach are also more susceptible to bias and more likely to accept information as true if it is consistent with their beliefs (de Dreu *et al.*, 1999).

Age, politics, personality, and media literacy influence how we interact with misinformation online

Older adults are more likely to encounter and share misinformation (Allcott & Gentzkow, 2017; Grinberg *et al.*, 2019; Guess *et al.*, 2020). In a survey of media consumption habits in the United States during the final weeks of the 2016 election, adults aged 60 years and older were found to consume more information from untrustworthy websites regardless of political affiliation (Guess *et al.*, 2020). However, political ideology appears to be an important complicating factor in predicting older adults' interactions with misinformation. Twitter users in the United States with conservative political affiliations encountered upwards of 15% more misinformation every week (depending on their media consumption rates) compared to those with liberal affiliations; this trend was exacerbated by age, as older adults with conservative affiliations encountered the highest levels of misinformation (Grinberg *et al.*, 2019). Conservative political ideology was also associated with sharing misinformation; Grinberg *et al.* (2019) found that, among U.S. Twitter users who share high volumes of misinformation (i.e., "superspreaders"), a disproportionately high number identified as female Republicans aged 50 years and older. In contrast, Jones-Jang *et al.* (2021) found that older adults with liberal political views tended to be better able to distinguish between fake and real news stories.

Older adults may share more misinformation not because they are misled into believing the message is correct, but because they prioritize interpersonal goals over accuracy (Brashier & Schacter, 2020). While Allcott and Gentzkow (2017) found that, overall, older adults tended to be less capable of correctly identifying fake headlines, the authors also found that heavy media consumption and the level of segregation in one's social network (i.e., how many of the participants' social media friends prefer the same presidential candidate they did) also influences their ability to distinguish misinformation. We share misinformation — whether we believe it or not — for various reasons, including to obtain other people's opinions, to express our own opinions, to interact with others, and to build relationships (reviewed in Metzger *et al.*, 2021).

Aspects of personality also influence our susceptibility to misinformation; less agreeable and more extroverted people are more likely to share information they know to be untrue (Buchanan & Benson, 2019; Buchanan, 2020), as are people inclined toward self-promotion and those who exhibit lower self-regulation (Islam *et al.*, 2020). Higher risk-taking behaviour has been identified as predisposing some people to misinformation (Whittle *et al.*, 2013; Koohikamali & Sidorova, 2017). Thus, a better understanding of how to decrease our reliance on intuitive processing could help mitigate the effects of misinformation (Pennycook *et al.*, 2016).

Digital media literacy — the ability to effectively distinguish the reliability of online content — reduces vulnerability to misinformation, though it declines with age (Brashier & Schacter, 2020; Kim *et al.*, 2021). For example, Amazeen and Wojdynski (2020) found that, while only 9% of media consumers noticed when news stories were labelled as sponsored content, the likelihood of recognizing such native advertisements[16] decreases significantly with age. Other factors may predispose older adults to being fooled by false claims, such as susceptibility to repeated exposure or higher levels of interpersonal trust (Brashier & Schacter, 2020). However, age is not exclusively associated with vulnerability to misinformation — aging can also improve our ability to identify false information, because we acquire more general knowledge and tend to have a greater awareness of the limits of our knowledge (reviewed in Brashier & Schacter, 2020). Interventions to improve digital literacy have been shown to reduce older adults' susceptibility to misinformation (e.g., Moore & Hancock, 2022).

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[16] Native advertisements are sponsored (i.e., paid) content that, while labelled as such, are designed to look the same as other, unpaid content. They are a widely used form of advertisement across media outlets, including reputable news media sources (Amazeen & Wojdynski, 2020).

5.2 Successfully Countering Misinformation

Effectively countering misinformation entails preventative measures such as supporting the identification of misinformation, as well as providing corrections after inaccurate information is offered, and using the best available messenger and medium (Table 5.3). Generating and disseminating high-quality, understandable information supports informed decision-making and debunks misinformation (Murthy, 2021). However, even high-quality, easily understood information requires the correct delivery, context, and messenger to be persuasive (Hawkins *et al.*, 2008; Dhanani & Franz, 2020; Chu *et al.*, 2021). Using combinations of validated debunking techniques increases efficiency and reduces misinformation's continued influence on cognition (Kan *et al.*, 2021; Bak-Coleman *et al.*, 2022).

Table 5.3 Strategies That Improve Trust, Quality, and Uptake of Scientific Information

Strategy	Reference
Indicate the presence of misinformation	Clayton *et al.* (2020); Brashier *et al.* (2021); Cacciatore (2021); Jennings and Stroud (2021); Pennycook and Rand (2021)
Inoculate against the techniques used in misinformation	Cook *et al.* (2017); Roozenbeek and van der Linden (2019); Lewandowsky and van der Linden (2021); Maertens *et al.* (2021)
Improve access to increase trust in academic research	Yavchitz *et al.* (2012); Sumner *et al.* (2014); Parker *et al.* (2021)
Provide reliable, independent, fact-checked validation and corrections	Bodenhausen *et al.* (1994); MacKuen *et al.* (2010); Koch and Forgas (2012); Weeks (2015); Vosoughi *et al.* (2018); Forgas (2019)
Accurately convey uncertainty to build increased credibility and trust	Jensen *et al.* (2011); Ratcliff *et al.* (2018); Flemming *et al.* (2020)
Choose the correct messenger and medium to deliver information	Hunt and Wald (2018); Cone *et al.* (2019); Huang and Wang (2020); Ratcliff and Sun (2020); Ward and Budarick (2021)

5.2.1 Identifying and Indicating Misinformation

Indicating that misinformation is inaccurate is a promising way to improve our ability to recognize it and reduce its influence (Brashier *et al.*, 2021). Warnings about misleading information, usually through some form of "false" label, can help increase judgments of accuracy and reduce the sharing of misinformation (Brashier *et al.*, 2021). Labels, such as "false," "disputed," or "fact-checked," are helpful because they make use of our tendency to only share information that we believe is accurate (Cacciatore, 2021; Jennings & Stroud, 2021; Pennycook & Rand, 2021). For example, participants in an experiment were less likely to pass along information they viewed as less credible (Mena, 2020). Another promising approach to shielding the public against misinformation is highlighting the types of flawed arguments and explaining the general techniques used by purveyors of misinformation. This strategy is known as inoculation (Figure 5.2).

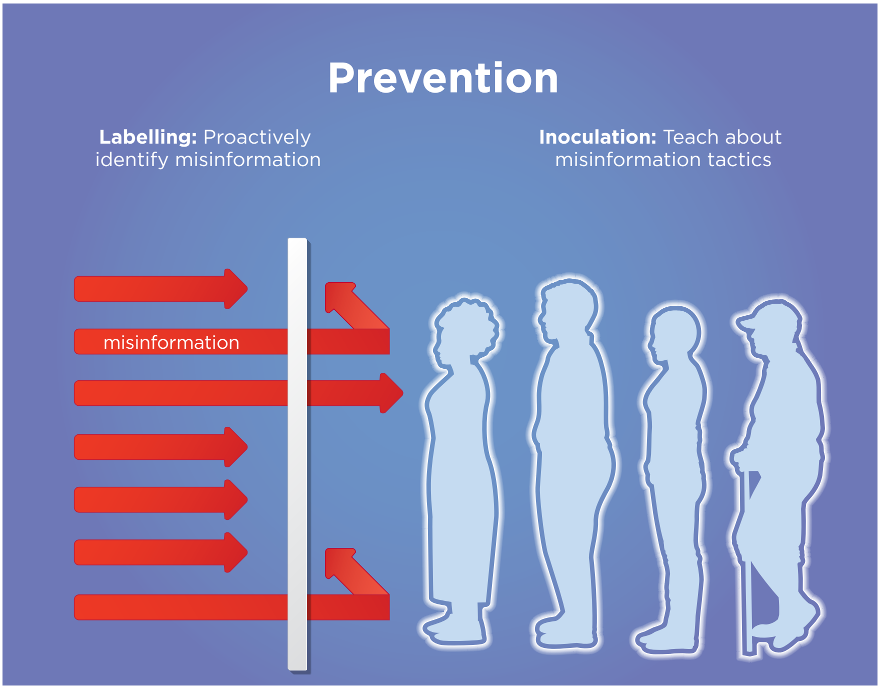

Prevention
Labelling: Proactively identify misinformation
Inoculation: Teach about misinformation tactics
misinformation

Figure 5.2 Labelling and Inoculation Limit Exposure to and Belief in Misinformation

Multiple levels of prevention, such as labelling and inoculation, help protect us from believing misinformation.

Timing, language, and context influence labelling effectiveness

Simple true or false labels seem to be most effectively applied after exposure to a misinformation message. For example, Brashier *et al.* (2021) tested readers' ability to accurately classify headlines as misinformation one week after exposure to labels applied either before, after, and while they read the headlines. Readers' misclassification of headlines was reduced by 25% when they were exposed to labels after seeing the headline, compared to 8.6% when labels were present while they were reading, and 5.7% for those who saw labels before the headline (Brashier *et al.*, 2021). . The language used to flag misinformation also impacts effectiveness. Though the message conveyed in fact-checking labels is relatively simple, the strength of the language used can influence their effectiveness. For example, a "rated false" label — which tells us explicitly that the information is untrue — is more effective at reducing our belief in the misinformation than a "disputed" label, which creates ambiguity around the validity of the statement (Clayton *et al.*, 2020). Having a specific label attached to an article is also more effective at reducing (but not eliminating) belief in misinformation than using a general warning (i.e., warning about potential misinformation but not explicitly linking to the content of the article) (Ecker *et al.*, 2010; Clayton *et al.*, 2020). Offering context, for example by providing "true" labels for verified information alongside "false" ones, also improves this strategy (Pennycook *et al.*, 2020b).

Revealing the techniques used by misinformation providers can neutralize misleading messages

Inoculation can proactively counteract misinformation by explaining misleading techniques found in misinformation thus enhancing our ability to identify it. By teaching people to better discern the truth, this strategy may be scalable to larger groups because its effectiveness is independent of specific counter-arguments to misinformation (Roozenbeek & van der Linden, 2019).

In the context of climate change, people who were taught about the use of fake experts to promote misinformation were better able to discern false messages (Cook *et al.*, 2017). Educating people about the techniques used to promote misinformation may increase our awareness of such messaging and decrease our vulnerability to it (Cook *et al.*, 2017). Improving our ability to detect manipulative techniques, as well as pre-emptively labelling misinformation, can reduce our exposure to misinformation. Reducing exposure is a priority, because corrections will not always reach those who are misinformed (Gray, 2017; Garcia & Shane, 2021; Roozenbeek *et al.*, 2022). As the saying goes, "an ounce of prevention is worth a pound of cure."

5.2.2 Providing Accurate Refuting Information

As it is impossible to label every piece of misinformation or to perfect every person's ability to detect misinformation, providing well-formulated, accurate information to help debunking efforts is also necessary to address misinformed beliefs. Debunking has been used to effectively counter climate, nutrition, wellness, and vaccine misinformation (Jolley & Douglas, 2017; van der Linden *et al.*, 2017; Lelieveld & Andersen, 2019; Maertens *et al.*, 2020; Fong *et al.*, 2021). Providing even a short 140-character refuting response is more effective than a simple label for the long-term correction of misinformation and its continued effect on thoughts and behaviours (Ecker *et al.*, 2020). Just as misinformation can be crafted to maximize credibility and spread, the messages used to correct a falsehood have to be well crafted to maximize reach. To be effective, debunking requires careful consideration of the audience's needs, the content offered, and how the content is presented (Figure 5.3).

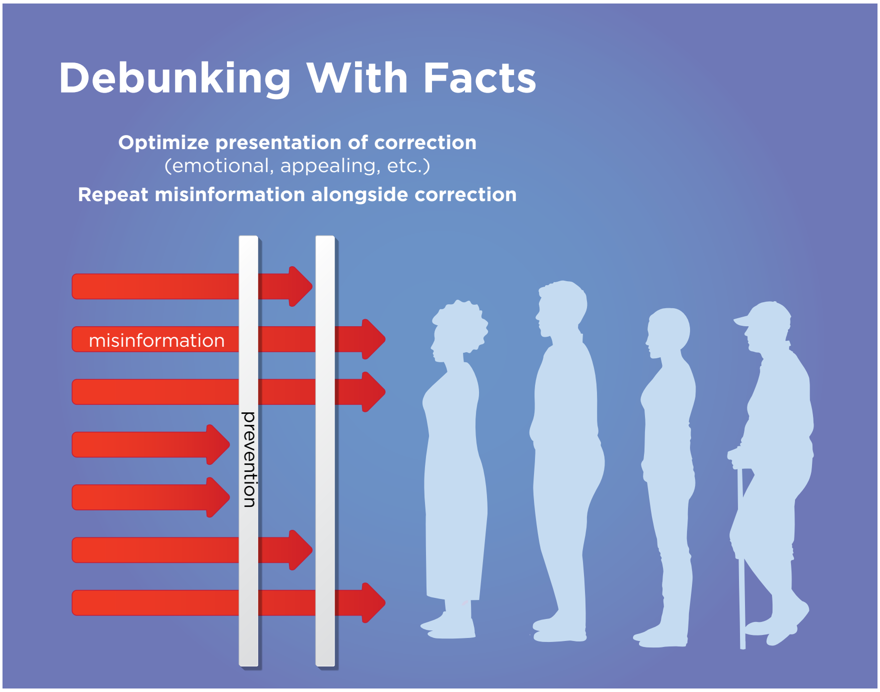

Debunking With Facts
Optimize presentation of correction
(emotional, appealing, etc.)
Repeat misinformation alongside correction
misinformation
prevention

Figure 5.3 Providing Accurate Science and Health Information Reduces Reliance on Misinformation

Once misinformation is believed, it can be debunked with optimally presented facts that are repeated and paired with a piece of misinformation to directly refute it.

Including new evidence to refute misinformation can be an effective debunking tool

Refuting misinformation with new evidence is more effective when that new information explains why the initial misinformation is incorrect (Seifert, 2002; Rapp & Kendeou, 2007). Misinformation accompanied by a refutation helps promote correction of misinformed beliefs and detection of inconsistencies (van den Broek & Kendeou, 2008). Refutations can be tailored to specific groups, such as academics, patient advocacy groups, policy-makers, or even to individuals (Hawkins *et al.*, 2008; Goldstein *et al.*, 2020). An effectively tailored message increases the reader's attention, reduces the effort required to process the information, enhances relevant emotional cues, and creates a personal connection to the material (Hawkins *et al.*, 2008). A surprising message is more effective for correcting memory because surprising things are easier to remember (Fazio & Marsh, 2009). Simple and direct messages are more effective at correcting misinformation than complex ones because they are easier to remember and understand (Lewandowsky *et al.*, 2012a).

A single repetition of a piece of misinformation along with a correction increases the accuracy of beliefs, thereby lessening the effect of misinformation (Ecker *et al.*, 2017; Wahlheim *et al.*, 2020). Repeatedly presenting truthful information improves the efficacy of correction (Ecker *et al.*, 2011). So does providing more counter-arguments — four to six counter-arguments, for example, work better than two (Ecker *et al.*, 2019). Sustaining corrective efforts over longer periods of time is also important. For example, multiple readings and lectures that refuted psychological misperceptions, delivered over longer periods, were more effective at correcting those misperceptions than standard lectures that were not structured around direct refutations (Kowalski & Taylor, 2009).

Clear communication of scientific consensus, uncertainty, and risk are important to counter misinformation

Many studies have demonstrated that providing evidence of scientific consensus on a topic (e.g., using clarifying statements or visual examples) reliably shifts public opinion toward the scientific consensus. This has been observed with respect to climate science, vaccines, GMOs, and nuclear power (Dixon *et al.*, 2015; Dixon, 2016; Bolsen & Druckman, 2018; Kerr & Wilson, 2018; Kobayashi, 2018; van der Linden *et al.*, 2018). Climate change consensus messaging not only increases acceptance but, importantly, also support for policies that address climate change (van der Linden *et al.*, 2015). Within health messaging, conveying the consensus of doctors about vaccine effectiveness increases vaccination rates (Bartoš *et al.*, 2022). Visuals were more persuasive than text when presenting the evidence of consensus, especially among those who have lower trust in science (Dixon *et al.*, 2015).

Reporting and sharing scientific information are important in situations of new and evolving scientific understanding. For example, during a public health crisis, there is value in sharing information before an expert consensus has been reached, such as information based on a preliminary understanding of new data. However, this increase in transparency exposes the public to the process of building scientific understanding, which can include hyperbole, disagreement, and retraction (Caulfield *et al.*, 2021). Avoiding hype in messaging by noting, for example, where data are weak or preliminary, helps to limit the spread of information that may ultimately prove false (i.e., become misinformation) as our scientific understanding is refined over time (Caulfield *et al.*, 2021).

Accurately presenting scientific uncertainty — that is, expressing the likelihood that a result may prove incorrect — is part of reporting on new evidence (Fernandes, 2021). Being transparent about uncertainty can increase credibility, trust, and understanding (Jensen *et al.*, 2011; Ratcliff *et al.*, 2018). Our perception of scientific uncertainty can be exploited to increase our acceptance of misinformation. However, interventions that emphasize the value of uncertainty as an indicator of scientific transparency and quality increase our trust in scientific literature (Flemming *et al.*, 2020). A greater acceptance of the literature has been shown by Flemming *et al.* (2020) to change behaviours in line with updated beliefs (e.g., donating money). Expressing uncertainty was also found to improve trust in climate data, even among those who do not accept climate change (Joslyn & LeClerc, 2016).

Accurate risk communication is valuable — overestimation of the risk of vaccines is a key mediator of vaccine refusal (Meszaros *et al.*, 1996). Metaphorical language and visuals can be effective tools for risk communication (Bielenia-Grajewska, 2015; Hallgreen *et al.*, 2016). For example, during the COVID-19 pandemic, the "flatten the curve" slogan and visuals were used to communicate risk with some success (Ruão & Silva, 2021). Other strategies include providing patients with combined safety and risk data (e.g., 99.99% safe along with 0.01% chance of adverse effects), which may help patients better understand costs and benefits (Duong, 2021). Focusing on the benefits, rather than losses, of an intervention increases positive health behaviours (Gantiva *et al.*, 2021). Comparing risks associated with other familiar daily activities, such as driving a car or taking over-the-counter medications, can also help people better understand the relative risks of COVID-19 vaccines (Duong, 2021).

5.2.3 Using the Appropriate Messenger and Medium for Information

The quality of information is one of many factors that influences what information we believe and the effectiveness of corrections. Who delivers the message (e.g., the person or institution), and how that message is delivered to us (e.g., as a fact or in a narrative), as well as the presentation of the message (e.g., as a visual or as text) all affect the uptake and persuasiveness of misinformation (Figure 5.4).

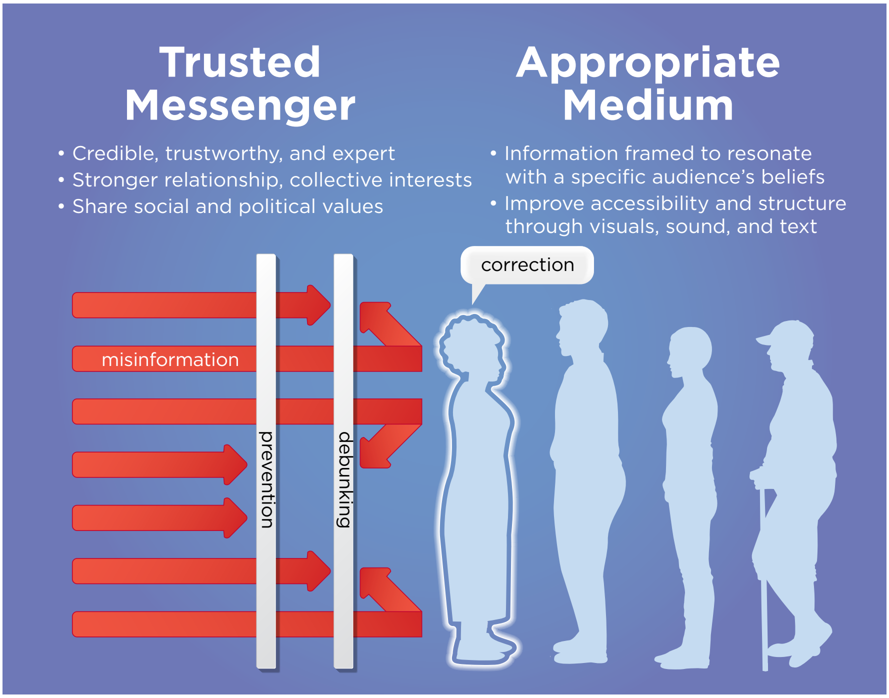

Trusted Messenger
• Credible, trustworthy, and expert
• Stronger relationship, collective interests
• Share social and political values
Appropriate Medium
• Information framed to resonate with a specific audience's beliefs
• Improve accessibility and structure through visuals, sound, and text
correction
misinformation
prevention
debunking

Figure 5.4 Having an Appropriate Messenger and Medium Improves Correction

Accessible corrections received from messengers we trust and believe are viewed as credible and are more effective.

Perception of the messenger influences the effectiveness of the corrective information

The trust and credibility of those delivering information impact the effectiveness of debunking efforts. The effectiveness of a messenger and the delivered correction depends on their perceived trustworthiness (Ecker & Antonio, 2021). We gauge the believability of information in part based on the perceived credibility of the person or organization delivering it, which in turn enhances or diminishes correction (Cone *et al.*, 2019). How someone determines the credibility of a source is complex, and involves factors such as trustworthiness, expertise, and goodwill (Hunt & Wald, 2018). Corrections viewed positively across multiple dimensions may be the most effective; for example, reduced skepticism about climate change and GM foods is correlated with the higher trustworthiness, expertise, and goodwill associated with the messenger (Hunt & Wald, 2018). We use relationships as an indicator of trust and are therefore more likely to share information from those we have relationships with (American Press Institute, 2017; Buchanan, 2021). Leveraging personal relationships can help promote the sharing and uptake of accurate information (Acemoglu *et al.*, 2021).

Shared moral values is another factor in assessing the trustworthiness of a messenger. Social media users are more likely to accept corrections from users with whom they have a stronger relationship, probably because of shared collective interests among their friends and community (Margolin *et al.*, 2018). In some circumstances, a non-partisan organization may be an appropriate messenger to respond to misinformation, while a partisan messenger may be better suited in others. For example, in the United States, a Republican debunking a Republican-spread healthcare rumour is more effective than a non-partisan individual or a Democrat doing the same thing (Berinsky, 2017). Having information delivered by trusted public figures can foster acceptance of information, even if the messengers are not experts. For instance, unvaccinated Christians in the United States are more likely to accept a vaccine endorsement from scientists who are Christian because of the perception of shared values, regardless of that scientist's expertise in vaccination (Chu *et al.*, 2021).

Narratives and medium can help counter misinformation

Because we like to believe we are right, framing a refuting message so it is compatible with an audience's beliefs improves message uptake (Kahan, 2010). In science communication, framing refers to how a message is constructed — this includes building a narrative, simplifying the information, and emphasizing some aspects over others, so that it resonates with the intended audience (Yang & Hobbs, 2020). For instance, describing actions to mitigate climate change as "patriotic" (e.g., "the American way of life") or calling a tax a "carbon offset" can make the message more resonant with an individual's political ideology (Feygina *et al.*, 2009; Hardisty *et al.*, 2009; Lakoff, 2014, 2016). Aligning messages with the intended audience's moral values can help communicate policy options on otherwise controversial topics, by focusing on areas of agreement rather than subjects confounded by misinformation (e.g., having conversations about jobs created by green energy rather than emissions reductions).

Narrative corrections use plot and character to convey outcomes; they are distinct from non-narrative message constructions that use reasoning, facts, or statistics (Green & Brock, 2000; Slater & Rouner, 2002). Narrative and non-narrative corrections are thought to engage distinct psychological processes (Slater & Rouner, 2002). Narratives may be particularly effective when used in parallel with other strategies, as a mechanism to reduce defensive reactions to corrections, or as an alternative when other strategies prove ineffective (Slater & Rouner, 2002; Huang & Wang, 2020; Ratcliff & Sun, 2020). Storytelling can be used to personify messaging about risk, convey the moral virtue of vaccination, and legitimize authoritative sources (Ward & Budarick, 2021). For example, narratives can help medical practitioners encourage vaccine acceptance, as narratives can acknowledge the emotion involved in the decision and help us understand risk by relating it to the family unit (Dubé *et al.*, 2015). However, storytelling is not used only in scientific communication — it is also a frequent strategy of those who create and spread misinformation. As such, Dahlstrom and Scheufele (2018) advise caution when using narratives. Using them to increase engagement can risk elevating stories above scientific evidence, leading to other plausible-sounding anecdotes (such as those containing misinformation) being given equal consideration (Dahlstrom & Scheufele, 2018).

Other communication media, such as visuals, are valuable tools for accurately conveying consensus and risk. For example, memes offer a way to combine accurate information, emotion, and engaging visuals to increase vaccination intention (Geniole *et al.*, 2022). While memes are an effective format for correcting misinformation, potential drawbacks are that over time memes can become sarcastic and derogatory toward out-groups and are viewed through a political lens (Harvey *et al.*, 2019). Video corrections carry distinct benefits, such as holding our attention while providing structure and an organized argument (Rosenthal, 2020). Videos can include different kinds of messages that effectively counter misinformation, such as descriptions of misinformation strategies, corrective messages, and relevant personal narratives, resulting in changes in behaviour (Ophir *et al.*, 2020; Breza *et al.*, 2021; Lewandowsky & Yesilada, 2021; Johnson *et al.*, 2022). Offering messaging across multiple modes, such as visual, audio, text, and gesture, can help in the communication of complex information (Johnson *et al.*, 2022).

6

Leading Practices for Responding to Misinformation

6.1 Addressing Sources of Misinformation

6.2 Reducing Susceptibility

6.3 Improving Societal Resilience

✓ Chapter Findings

- Addressing the challenges and impacts of misinformation requires a combination of immediate responses and long-term actions to counter spurious claims and build a resilient society.
- Identifying misinformation; increasing the availability of reliable, trusted information; and providing evidence in a clear, accessible, and persuasive way, can reduce the influence and spread of misinformation.
- Education, media literacy, and networks of trusted individuals can increase detection of and build societal resilience to misinformation.
- Rebuilding trust in institutions, including responding to community needs, is central to effective, long-term government outreach and response to misinformation.

Getting accurate information to those who need it, when they need it, and from a source they trust is paramount for inoculating us against misinformation (Walter & Tukachinsky, 2020; Swire-Thompson *et al.*, 2021). Addressing a problem of such scale — one created through actions as small as clicking the Share button and as large as coordinated campaigns from hostile governments — will, in the Panel's view, require all of us to play our part. Interventions can be targeted anywhere along the pathway from the genesis of misinformation to its ultimate translation into actions with measurable impacts.

6.1 Addressing Sources of Misinformation

Most sources of misinformation — such as corporate interests, malicious actors, social and partisan media, or self-interested individuals — are not subject to scientific rigour, peer review, or journalistic standards; however, there are cases where misinformation can arise from inadequate scientific transparency and rigour, as well as from poor reporting or failures to meet journalistic standards (Shin *et al.*, 2018; Cook, 2019; Hiar, 2021).

6.1.1 Knowledge Production and Science Communication

Science and health information and communication are essential to navigating the modern world. It is vital, then, that science and health information be high-quality, understandable, and trusted to provide the greatest benefit to people while simultaneously preventing the ambiguity that misinformation purveyors exploit. High-quality scientific data are necessary for many strategies that counter misinformation; however, research that does not conform to the standards of science, or that is poorly presented or over-hyped, can undermine trust and become a source of misinformation itself.

Scientists and academics are increasingly concerned about the role that poor-quality science and science communication play in contributing to misinformation (Parker *et al.*, 2021). Scientific discoveries are filtered through academic institutions, pre-prints, peer-reviewed journals, and social and traditional media before reaching their target audiences. This creates many opportunities for misinformation to arise. Granting easier access to high-quality science and health information, changing publishing incentives to prevent rushed research, removing financial conflicts, and increasing research oversights can all be effective measures in limiting the production of poor-quality data (Parker *et al.*, 2021).

Improving the accessibility of research by removing paywalls and incentivizing plain-language publications can facilitate public understanding and prevent the misinterpretation of findings (Parker *et al.*, 2021). Training scientists to present information as visuals and narratives can also help to better engage and inform the public (Parker *et al.*, 2021). Press releases and abstracts are essential tools that scientists and universities use to share information with the media and public; however, these often contain spin, oversimplifications, or exaggerations that are uncritically reflected or amplified in subsequent reporting (Yavchitz *et al.*, 2012; Sumner *et al.*, 2014). Competition and self-promotion in the academic environment incentivize hype, but better self-monitoring by universities and researchers, or more time allowed for journalists to verify claims, may help reduce the risk of hype leading to misinformation (Sumner *et al.*, 2014).

More trust in knowledge-generating and -disseminating institutions would extend the reach of correction

Those promoting misinformation and conspiracy theories about topics such as vaccination and climate change often attack the expert institutions that generate accurate information (DiResta *et al.*, 2018; Gill, 2020; Tenove, 2020; Rudyk, 2022). Declining institutional legitimacy increases public vulnerability to misinformation (Bennett & Livingston, 2018). Institutions that are important sources of data, such as Statistics Canada, are the targets of misinformation aimed at undermining their credibility, requiring them to invest considerable time and resources to respond (StatCan, 2021b). Such targeted misinformation campaigns are able to exploit the broader trend of declining public trust in Canadian institutions (Kavanagh & Rich, 2018; Gill, 2020).

As both generators and disseminators of knowledge, our public institutions have the potential to improve responses to misinformation (Sullivan, 2019; Gisondi *et al*., 2022). In a survey of technologists, scholars, practitioners, and strategic thinkers, Anderson and Rainie (2017) found widespread agreement on the importance of public institutions as sources of information that people can trust, when they are guided by clear ethical standards and act in service of the public good. This common good, however, cannot be achieved without adequate staffing and financing (Anderson & Rainie, 2017). Supporting these institutions and ensuring they are properly resourced are critical to combatting misinformation (Sullivan, 2019; Gisondi *et al*., 2022). Trust in knowledge institutions increases when they are seen to be independent, transparent, and accountable through effective oversight (Pavleska *et al*., 2018). Independence includes freedom from financial conflicts and partisan or political agendas (Catterall, 2014; Jackson, 2021a). Actions that increase transparency and accountability include more public access and outreach, open research processes, and full disclosure of funding sources (Pavleska *et al*., 2018). Greater transparency about the threat misinformation poses to an institution can "contribute to societal learning and resilience, improving public trust" (PS, 2021).

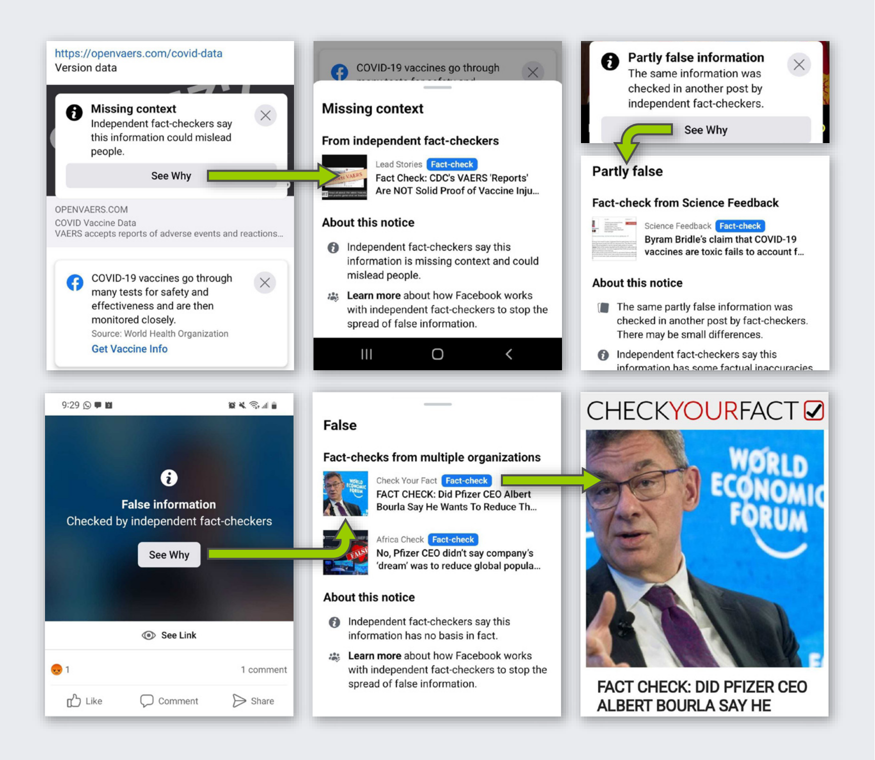
A diversity of independent knowledge institutions helps more people access accurate information (Gill, 2020). We vary considerably in where we place our trust. Some of us, for example, trust information from scientific organizations and environmental groups. Others trust government agencies, while those who have low levels of trust in government may see university scientists, news media, and science media as more credible when they are not connected to the government (Brewer & Ley, 2013; Gill, 2020). Strengthening oversight also increases trust. Institutions that are responsible for oversight will have to develop significant evidence of accountability and effectiveness to be seen as trusted and credible (Pavleska *et al*., 2018).

6.1.2 Social Media

Technology companies respond to misinformation primarily by detecting and removing it or reducing its spread. Other measures include flagging misinformation for users and providing access to accurate information. Currently, social media companies (often with the aid of fact-checking organizations) decide what qualifies as misinformation and what warrants intervention (Waddell, 2020; Scales *et al*., 2021). In the European Union, regulations such as the *Digital Services Act* and *Digital Markets Act* attempt to mitigate misinformation (European Parliament, 2022a, 2022b). While such regulations are designed to be applied more broadly than science and health misinformation, it is possible they could be applied there as well (Satariano, 2022).

Fact-checking organizations play an important role in a healthy information environment

Detecting misinformation is the first step in countering it, and fact-checking organizations have become an essential component of this process. Fact checking can authenticate information from a variety of sources, including celebrities, politicians, social media, partisan journalism, and non-specialists. Fact-checking organizations address misinformation by engaging their audiences directly (Brashier *et al.*, 2021; Garcia & Shane, 2021) or through partnerships with social media companies (Ardill, 2021; Facebook, 2021) (Figure 6.1). COVID-19 misinformation drove a surge in fact checking that correlated with expanded user engagement with fact-checking organizations (e.g., AP Fact Check, PolitiFact) (Brennen *et al.*, 2020; Yadav *et al.*, 2021).



https://openvaers.com/covid-data
Version data

Missing context
Independent fact-checkers say this information could mislead people.

OPENVAERS.COM
COVID Vaccine Data
VAERS accepts reports of adverse events and reactions...

COVID-19 vaccines go through many tests for safety and effectiveness and are then monitored closely.
Source: World Health Organization

COVID-19 vaccines go through

Missing context

From independent fact-checkers

Lead Stories
Fact Check: CDC's VAERS 'Reports' Are NOT Solid Proof of Vaccine Inju...

About this notice

Independent fact-checkers say this information is missing context and could mislead people.

Learn more about how Facebook works with independent fact-checkers to stop the spread of false information.

Partly false information
The same information was checked in another post by independent fact-checkers.

Partly false

Fact-check from Science Feedback

Science Feedback
Byram Bridle's claim that COVID-19 vaccines are toxic fails to account f...

About this notice

The same partly false information was checked in another post by fact-checkers. There may be small differences.

Independent fact-checkers say this information has some factual inaccuracies

9:29

False information
Checked by independent fact-checkers

1
1 comment

False

Fact-checks from multiple organizations

Check Your Fact
FACT CHECK: Did Pfizer CEO Albert Bourla Say He Wants To Reduce Th...

Africa Check
No, Pfizer CEO didn't say company's 'dream' was to reduce global popula...

About this notice

Independent fact-checkers say this information has no basis in fact.

Learn more about how Facebook works with independent fact-checkers to stop the spread of false information.

CHECKYOURFACT

FACT CHECK: DID PFIZER CEO ALBERT BOURLA SAY HE

Figure 6.1 Fact-Checking Labels and Corrections on Facebook in Response to Misinformation

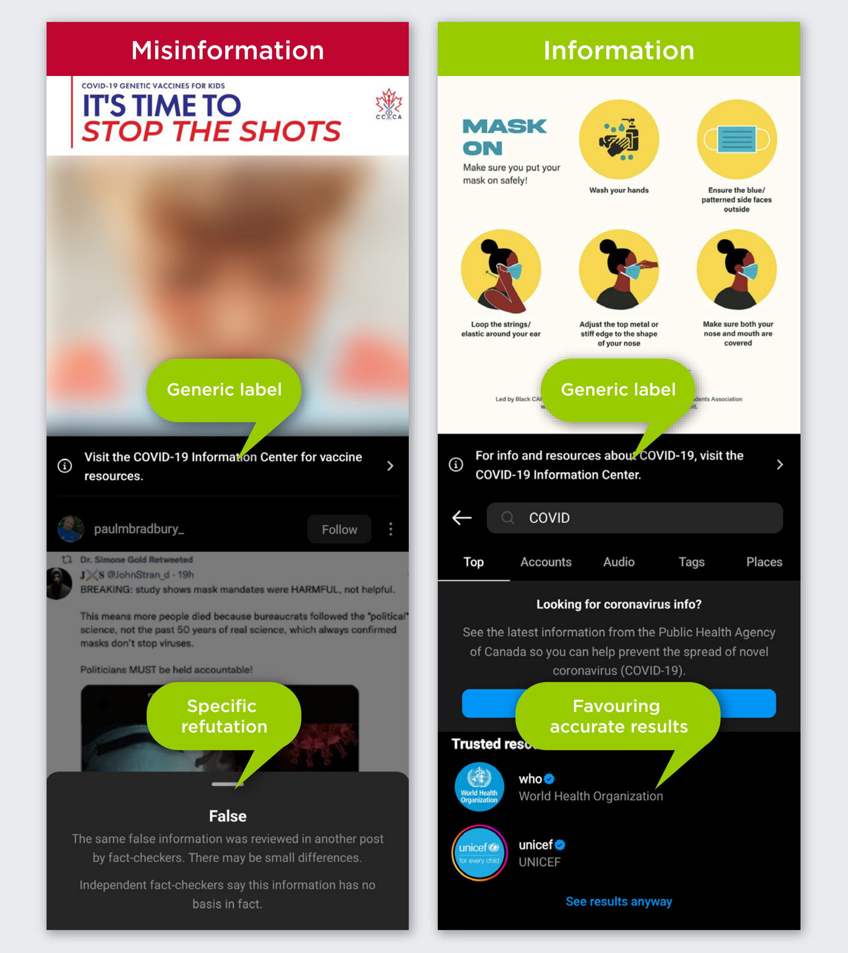
Facebook uses independent fact-checkers to label and respond to COVID-19 misinformation. The responses range from addressing missing context to correcting false information.

Various fact-checking and debunking strategies and organizations have been created to address the speed and scale with which misinformation is spread, especially by bots. Social media companies such as Facebook and TikTok use independent fact-checking companies to identify misinformation, but this process is time-consuming (Ardill, 2021; Facebook, 2021). Initiatives, such as ScienceUpFirst, use social networks to amplify expert-vetted posts in order to help address the magnitude of the problem (ScienceUpFirst, 2022). Other groups have used memes and humour as a mechanism to help overcome the funding and marketing of climate change misinformation (Telford, 2021). In the current media environment, these groups act as a link between knowledge producers, such as scientists and journalists, and social media users.

Automating the detection and response to misinformation could be an effective way to expand fact-checking and labelling efforts (Facebook, 2020; Perez, 2020; Floodpage, 2021). Such innovations are considered necessary because misinformation spreads faster than accurate information, and because it arises rapidly in a crisis (Vosoughi *et al.*, 2017, 2018; Lee *et al.*, 2021). Automated fact-checking platforms work in two stages. First, they identify misinformation using a combination of language detection, user information, and network information (Vosoughi *et al.*, 2017). Second, they implement strategies such as nudging readers with a label (e.g., "low credibility") or debunking false claims with accurate information (Vosoughi *et al.*, 2017; von der Weth *et al.*, 2020). These techniques, however, are language-specific — for social media content in languages other than English, there is a general lack of language capacity, as well as language-specific context labels and information, available to address the issue (Molter, 2021). Such disparities could begin to be dealt with by increasing the attention given to misinformation in languages other than English (Coleman, 2021; Molter, 2021). Automated detection is also limited by the difficulty of detecting misinformation in audio and video formats.

Labelling misinformation can help social media users navigate around it

There is promising research testing the effects of labels on reducing the spread of misinformation across social media. When labels were added to simulated Facebook posts to indicate the presence of misinformation, it decreased those posts' credibility, leading to lower user intent to share (Mena, 2020; Zhang *et al.*, 2021b). Adding labels to simulated tweets improved attitudes towards vaccines across different groups, including people who were vaccine-accepting, vaccine-hesitant, and those who believed vaccine conspiracies (Zhang *et al.*, 2021b). Labelling some types of misinformation on social media already occurs. For example, Instagram uses labels on COVID-19-related topics to guide users to accurate information and to refute misinformation (Figure 6.2). Using labels to identify the information's source, such as those indicating that information comes from a news organization (e.g., “BBC is a British public broadcast service”) or foreign government (e.g., “a Russian government account”), can also improve discernment and reduce misinformation sharing behaviours (Nassetta & Gross, 2020; Arnold *et al*., 2021). These types of labels are being employed for some topics on Facebook/Instagram, Twitter,[17] and YouTube (Nassetta & Gross, 2020; Arnold *et al*., 2021).


Misinformation
COVID-19 GENETIC VACCINES FOR KIDS
IT'S TIME TO
STOP THE SHOTS
CCCA
Generic label
paulmbradbury_
Follow
Specific refutation
Information
MASK ON
Wash your hands
Generic label
COVID
Top
Accounts
Audio
Tags
Places
Favouring accurate results
Trusted reso
who
World Health Organization
unicef
UNICEF
See results anyway

Visit the COVID-19 Information Center for vaccine resources.

Dr. Simone Gold Retweeted

J⚔S @JohnStran_d · 19h

BREAKING: study shows mask mandates were HARMFUL, not helpful.

This means more people died because bureaucrats followed the "political" science, not the past 50 years of real science, which always confirmed masks don't stop viruses.

Politicians MUST be held accountable!

False

The same false information was reviewed in another post by fact-checkers. There may be small differences.

Independent fact-checkers say this information has no basis in fact.

Make sure you put your mask on safely!

Ensure the blue/patterned side faces outside

Loop the strings/elastic around your ear

Adjust the top metal or stiff edge to the shape of your nose

Make sure both your nose and mouth are covered

For info and resources about COVID-19, visit the COVID-19 Information Center.

Looking for coronavirus info?

See the latest information from the Public Health Agency of Canada so you can help prevent the spread of novel coronavirus (COVID-19).

Figure 6.2 Instagram’s COVID-19 Misinformation Responses

Instagram provides labels and information on COVID-19-related posts whether the post is accurate or not, and then directs user to credible medical information.

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[17] Twitter’s policies have been in flux since its acquisition by Elon Musk.

The majority of articles on Twitter are shared without being read; accordingly, another way to increase the identification of misinformation and limit its spread is to introduce warnings to encourage people to read articles before sharing (Gabielkov *et al.*, 2016; Vincent, 2020; Ghaffary, 2021). Such a nudge aims to help users become better informed about what they share and gain more information in order to judge veracity (Vincent, 2020; Ghaffary, 2021). Labelling has a consistent, but moderate, effect on the detection and sharing of misinformation; however, there is little evidence that speaks to its long-term effectiveness in the wider population, though Twitter and Facebook are exploring its use in this way (Vincent, 2020). Fact-checking and labelling approaches are constrained, however, by the time it takes to review and respond, especially considering the speed and scale at which social media posts can be generated.

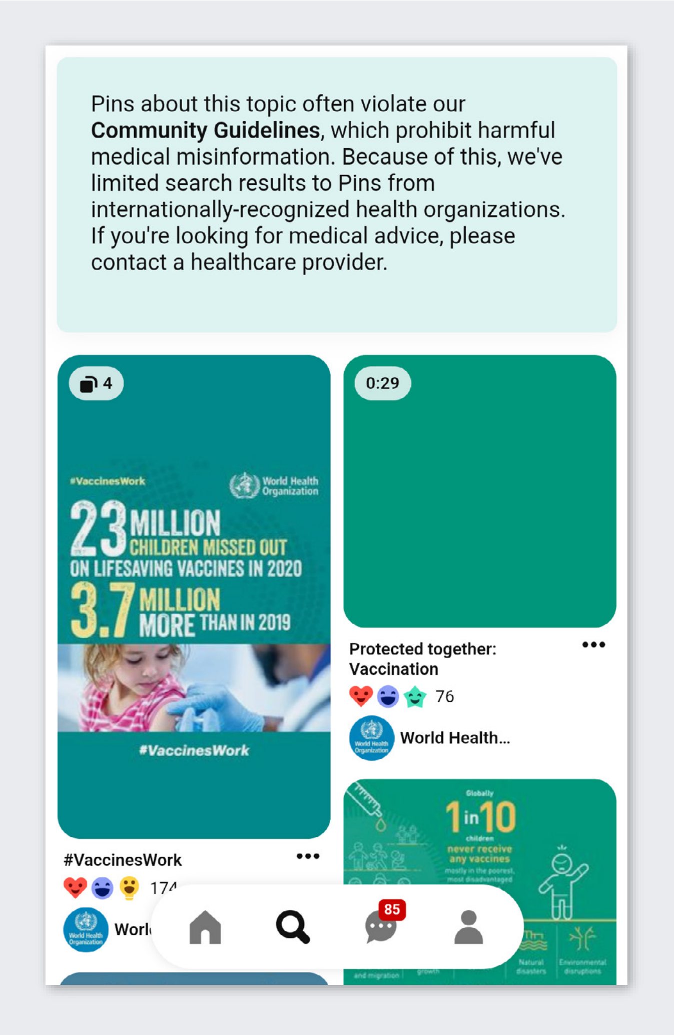
Removing misinformation or banning users can slow the spread of misinformation on social media

Once misinformation has been identified, social media platforms can choose to remove it entirely. For example, Facebook removed 18 million pieces of COVID-19 misinformation and labelled over 167 million pieces; Twitter has removed only 8,493 tweets; and TikTok's policy is to remove all misinformation that fails its fact-checking process (Gilmore, 2021a; Hernandez, 2021; Rojo, 2021). These policies may be particularly important because, once misinformation is encountered, even after correction, it continues to influence people's reasoning (Ecker & Antonio, 2021).

Though it is hard to determine the precise effect of any one policy, some evidence shows that the misinformation policies enacted by Facebook between 2016 and 2018 decreased interactions with sources of misinformation, while Twitter's misinformation problem worsened over the same period (Allcott *et al.*, 2019). After Facebook banned advertising by groups that disseminated misinformation, there was a 75% decrease in vaccine misinformation on Facebook compared to Twitter, supporting the argument that anti-vaccine profiteers produce a significant amount of misinformation (Chiou & Tucker, 2018). Examining the impacts of this type of policy, Zignal Labs found that banning prominent individuals can dramatically reduce the amount of misinformation on social media within a week (by 73%) (Ghosh, 2021). A similar ban on misinformation on YouTube not only reduced it on that platform, but also decreased misinformation-containing videos across both Facebook and Twitter (Alba, 2021c). Analysis of YouTube accounts that were de-platformed in 2018 and 2019 showed that, even when de-platformed users moved to other hosting services, removal from YouTube was still an effective means of limiting the spread of misinformation (Rauchfleisch & Kaiser, 2021). Though this strategy has been effective at removing some kinds of misinformation, there is continued evidence of a problem with respect to others, such as advertising ineffective health products for the treatment of cancer (Ohlheiser, 2022).

Social media companies can be a source of accurate information

Another method to address misinformation implemented by social media sites is to elevate accurate information. These programs build on studies that demonstrate that corrections, especially from expert organizations, are effective at reducing the effects of misinformation on social media (Vraga & Bode, 2017). On Facebook, the COVID-19 Information Center features fact-checked articles; a Context button provides background information about publishers and articles; and the Related Articles feature displays third-party fact-checked articles below associated stories (Facebook, 2018; Hughes *et al.*, 2018; Rosen, 2020). Twitter's warning labels contain links to information verified by Twitter or external trusted sources (Roth & Pickles, 2020). Pinterest has one of the strictest of these policies, limiting search results on numerous health topics to verified sources only (Pinterest, 2021) (Figure 6.3; Box 6.1).



Pins about this topic often violate our **Community Guidelines**, which prohibit harmful medical misinformation. Because of this, we've limited search results to Pins from internationally-recognized health organizations. If you're looking for medical advice, please contact a healthcare provider.

4
#VaccinesWork
World Health Organization
23 MILLION CHILDREN MISSED OUT ON LIFESAVING VACCINES IN 2020
3.7 MILLION MORE THAN IN 2019
#VaccinesWork
#VaccinesWork
174
Worl
0:29
Protected together: Vaccination
76
World Health...
Globally
1 in 10 children never receive any vaccines
85

Figure 6.3 Vaccine Search Results Limited to Verified Information on Pinterest

Box 6.1 The Effectiveness of Bans: Pinterest

Pinterest has taken some of the most significant measures to prevent misinformation from reaching its users. For topics such as vaccines, depression, and anxiety, search results only return information from verified sources such as Centers for Disease Control and Prevention, National Institutes of Health, and expert advice from medical professionals (Oyeniran, 2020; Pinterest, 2021). This information policy is in addition to a ban on health misinformation that has been in place since 2017 (Pinterest, 2021). Pinterest also has a partnership to facilitate engagement with healthcare professionals and outreach to underrepresented individuals in communities disproportionately affected by COVID-19 (Nadi, 2020; Pinterest, 2021).

An analysis comparing Pinterest content before and after its ban on vaccine misinformation and its promotion of credible vaccine information indicated that these efforts were successful (Guidry *et al.*, 2020). Prior to the ban, only 3.2% of HPV vaccine information originated from a reliable source, such as medical entities or the government. This proportion rose to 53.8% after Pinterest enacted its new content rules. Before the ban, posts that created barriers to vaccination (e.g., those about adverse effects, scary visuals, and conspiracy theories) made up 65.6% of posts, while only 13.0% contained information on the benefits of the HPV vaccine. After the ban, posts that highlighted the perceived benefits of vaccination (40.2%) or the severity of potential outcomes of HPV infection (22.1%) were the most common categories of posts, while barriers to vaccination posts fell to 11.3% (Guidry *et al.*, 2020).

Accurate health messages on social media improve pro-health behaviours, an important aspect of mitigating the effects of misinformation (Breza *et al.*, 2021; Monash University, 2021). An independent, controlled experiment about of health misinformation on Facebook found that public health messaging encouraging people to stay home for the holidays to prevent the spread of COVID-19 helped lower the infection rate by 3.5% over the 2020 Thanksgiving and Christmas holiday weekends in the United States (Breza *et al.*, 2021). Accurate messages have also been shown to help inform and dispel myths within specific communities, including low-income Black, Latino, and White communities (Monash University, 2021).

Because trusted relationships are integral to how we share information (American Press Institute, 2017; Buchanan, 2021), they can be used to help spread accurate information on social media (Acemoglu *et al.*, 2021). Social media users are more accepting of corrections from friends and others in their community (Margolin *et al.*, 2018). Thus, peer debunking contributes to an environment that supports accurate information dissemination and misinformation correction. Grassroots debunking on social media can pick up and amplify the messages of fact-checking organizations to respond to misinformation (Pennycook & Rand, 2019b). Some of us tend to update our beliefs when we observe others being corrected, which is another way social media can be used to help spread correct information (Vraga & Bode, 2017).

6.1.3 Journalism

Traditional news is an essential form of science communication through which the media shapes health perspectives and promotes beneficial behaviours, especially during public health emergencies (Isarta News, 2020; Zhang *et al.*, 2020b). Aspects of low-quality journalism, such as hype and sensationalized headlines, can contribute to misinformation, but high-quality, ethical journalism plays a vital role in addressing it (Grmuša, 2020) (Figure 6.4).

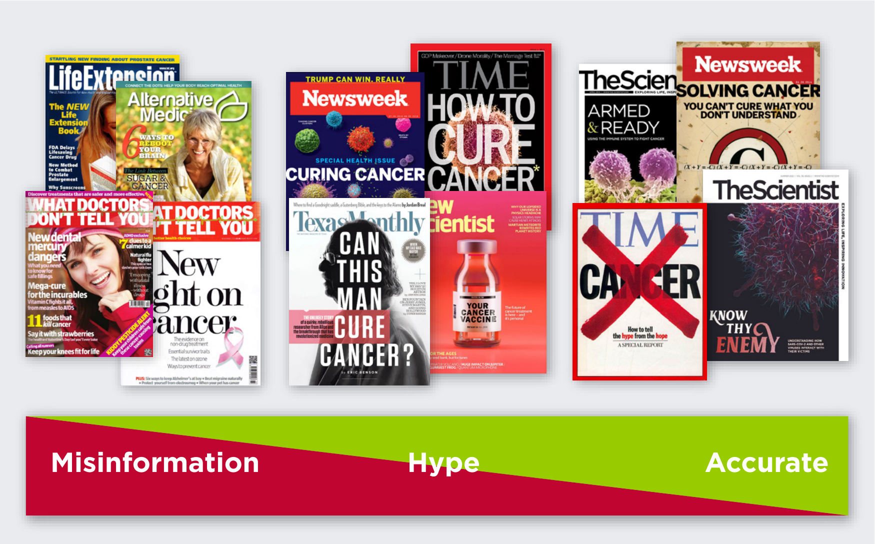

LifeExtension
Alternative Medicine
WHAT DOCTORS DON'T TELL YOU
WHAT DOCTORS DON'T TELL YOU
Newsweek
CURING CANCER
TIME
HOW TO CURE CANCER*
Texas Monthly
CAN THIS MAN CURE CANCER?
New Scientist
YOUR CANCER VACCINE
TheScientist
ARMED & READY
Newsweek
SOLVING CANCER
YOU CAN'T CURE WHAT YOU DON'T UNDERSTAND
TIME
CANCER
How to tell the hype from the hope
TheScientist
KNOW THY ENEMY
Misinformation
Hype
Accurate

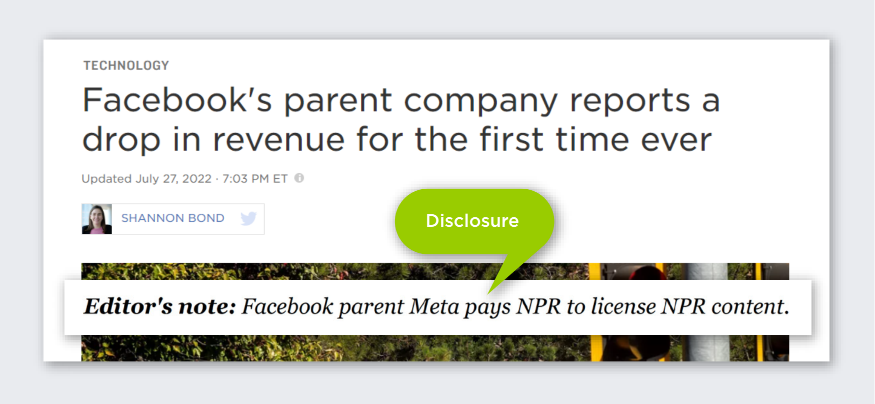
Figure 6.4 Spectrum of Health Information: Misinformation, Hype, and Accurate Reporting

Journalists can employ a variety of techniques to avoid hyperbole and promote accurate communication

In Canada, most people (i.e., > 50%) still trust many major Canadian news organizations (Newman *et al.*, 2022). A study of U.S. news outlets found that, overall, news stories do reflect the scientific consensus, and journalists actually tend to understate findings (Pei & Jurgens, 2021). However, more can be done to prevent the spread of misinformation, especially when reporting on evolving scientific knowledge (Merkley & Loewen, 2021). Journalistic practices that can improve reporting include using more diverse sources, avoiding reporting on single studies, and not rushing to publish stories based on the newest evidence (Jensen *et al.*, 2011; Hanage & Lipsitch, 2020; Saitz & Schwitzer, 2020). Reporting that uses a weight-of-evidence approach by examining the breadth of research on a topic produces work that is better supported and avoids misinformation created by false balance (Imundo & Rapp, 2021). Creating two-way communication between health professionals and journalists can build trust between them and increase the visibility and credibility of health information among a wider audience by improving dissemination across professional sectors and developing communication channels for emergencies (Donovan, 2020). Better reporting standards and collaboration may help journalists provide context and perspective while avoiding overemphasizing uncertain data and generating unwarranted hype (Jensen *et al.*, 2011). To assist in accurate science communication, journalistic organizations, such as the Science Media Centre of Canada, amalgamate resources on best practices, accurate data, and subject matter experts (Garcia, 2020; Mulcahey, 2020; Science Media Centre of Canada, 2021).

Identifying financial incentives and lobbying groups with vested interests is important for accurate journalistic communication

Eliminating financial conflicts can help bolster the public's trust in objectivity (Society of Professional Journalists, 2014), and understanding the financial incentives in producing science disinformation can help prevent its influence on reporting and science communication (Farrell, 2016). Identifying financial interests can be difficult, however, because financial contributions are frequently obscured from public view, though some organizations do disclose these conflicts (Figure 6.5). In the United States, messages from privately funded climate contrarian groups have shaped the framing and tone of climate reporting by news organizations, as well as in presidential speeches about climate, as evidenced by semantics data analysis (Farrell, 2016). Corporations in Canada have formed networks of similar climate-contrarian organizations (e.g., industry associations, think tanks, research institutes, and universities) to promote climate denial (Carroll *et al.*, 2018). Investigating conflicts of interest before reporting on health topics is an integral step in remedying misinformation (Cook *et al.*, 2007; Mulcahey, 2020).



TECHNOLOGY

Facebook's parent company reports a drop in revenue for the first time ever

Updated July 27, 2022 · 7:03 PM ET

SHANNON BOND

Editor's note: *Facebook parent Meta pays NPR to license NPR content.*

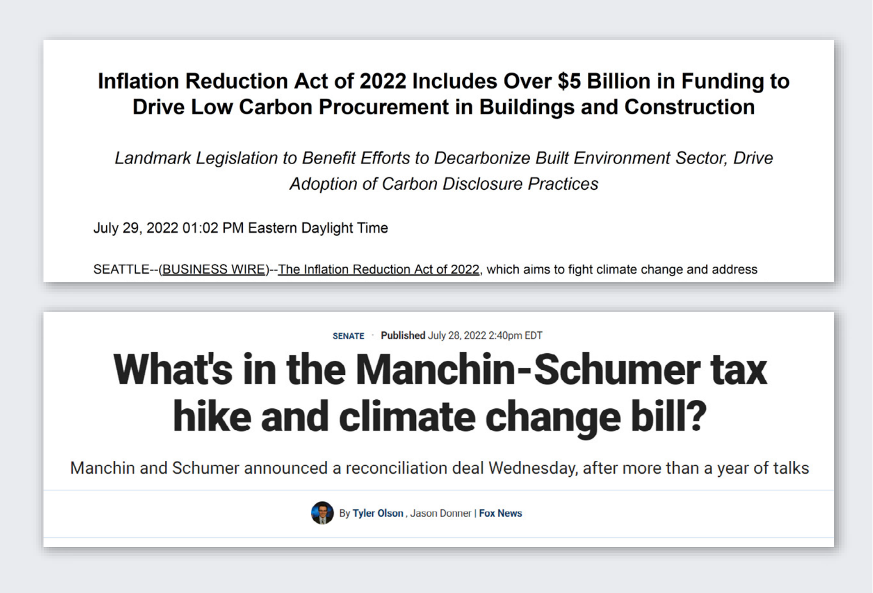
Figure 6.5 A News Organization's Financial Disclosure of a Social Media Company's Contributions

It is not only outside money that affects journalism. Changes in the funding of news media have affected news reporting (Webb, 2017). Internet companies (e.g., search engines, social media companies) have taken an increasingly large share of advertising revenues (Descôteaux & Brin, 2018; Barthel & Stocking, 2020). As newspaper revenues have declined, so too has staffing (Webb, 2017). Newsrooms have cut staff, local newsrooms have been closed, and local news organizations have gone out of business due to falling revenues (Adgate, 2021). Science journalism has been severely impacted by these changes (Brossard & Scheufele, 2013).

Reduced staff, page-view quotas, and advertising rates based on page-views create an environment that incentivizes sensational journalism that favours bad actors and misinformation (Searls, 2017). By writing news articles themselves, scientists might compensate for the loss of staff science reporters in news coverage, however the communication skills and journalistic rigour provided by independent reporters would be lost (Barel-Ben David *et al.*, 2020). Other solutions to address incentives issues involve changing the funding systems for journalism (Descôteaux & Brin, 2018). Many newspapers are increasingly funded by subscriptions rather than ads, which could remove the incentive for sensational journalism (Adgate, 2021). Efforts have been made to improve the compensation of news outlets by internet companies, but the current levels are still insufficient to address the problem (Hutchinson, 2020). Various government programs to support news media have been suggested, but government involvement in news challenges the perception of journalistic objectivity (Descôteaux & Brin, 2018).

Framing science journalism in inclusive and unbiased ways helps address misinformation

Some barriers to trust in, and uptake of, science journalism can be removed by improving the framing of science reporting. Many fields that are subjected to misinformation are complex. This complexity creates opportunities for accurate and impactful framing by choosing which data, risk, and benefits resonate with a particular audience (Figure 6.6). News framing can be critical to how audiences understand and evaluate issues by constructing messages that better reach underserved communities, even without correcting misinformed beliefs (Box 6.2). For example, using the term "conspiracy belief" may obscure or deny personal experiences where someone's mistrust results from historical and contemporary inequities (Jaiswal *et al.*, 2020). Jaiswal *et al.* (2020) suggest that it is ethically and strategically better to identify the underpinning of misinformation, such as agendas of power, racism, or mistrust resulting from social and economic exclusion. This framing strategy avoids blaming structurally disadvantaged communities for their perceptions and experiences while recognizing the sources of those disadvantages (Jaiswal *et al.*, 2020).



Inflation Reduction Act of 2022 Includes Over $5 Billion in Funding to Drive Low Carbon Procurement in Buildings and Construction

Landmark Legislation to Benefit Efforts to Decarbonize Built Environment Sector, Drive Adoption of Carbon Disclosure Practices

July 29, 2022 01:02 PM Eastern Daylight Time

SEATTLE--(BUSINESS WIRE)--The Inflation Reduction Act of 2022, which aims to fight climate change and address

SENATE · **Published** July 28, 2022 2:40pm EDT

What's in the Manchin-Schumer tax hike and climate change bill?

Manchin and Schumer announced a reconciliation deal Wednesday, after more than a year of talks

By Tyler Olson , Jason Donner | Fox News

Figure 6.6 The *Inflation Reduction Act* of 2022 Framed Differently by Different News Organizations

Box 6.2 Mitigating the Impacts of Misinformation Through Framing

Framing can mitigate the impacts of policy inaction of climate denial or opposition without being used to refute or persuade individuals about climate science (PPF, 2021). Because many of us are prone to loss aversion — a bias towards minimizing losses — we overvalue short-term losses and undervalue long-term gains (Hurlstone *et al.*, 2014). To reduce the effect of this bias, long-term gains that result from an action, which would be undervalued, can be reframed as the loss of those gains if the corresponding action is not taken. Changing framing from gains to losses has been shown to increase support for higher GHG emission cuts (Hurlstone *et al.*, 2014). Such framing techniques have been used successfully to pass climate change bills in other jurisdictions — in the United States, some analysts argue that strategically framing policies around economic benefits rather than climate change science led to the passing of the *Future Energy Jobs Act* and earned bipartisan support for a comprehensive climate-energy policy (Cann, 2021). In Canada, people have responded positively to framing that provides technical information about carbon capture technologies when exposed to different types of climate change messaging (Gifford & Comeau, 2011; Whitmarsh *et al.*, 2019).

Preventing or removing framing that distorts the public understanding of science can help counter misinformation. In Canada and the United States, the cost of implementing climate change mitigation is often framed in terms of economic losses; however from the 1980s through to the early 2000s the benefits were rarely discussed as economic gains (Young & Dugas, 2011; Stecula & Merkley, 2019). Framing can also be used to appeal to partisan ideologies — conservative newspapers emphasize uncertainty in climate science more than non-conservative newspapers (Stecula & Merkley, 2019). The types of framing that decreased support for climate action including those that differ along partisan lines declined substantially between 1988 and 2014 in the United States; however, long-term impacts (i.e., lack of policy action on climate change) serve as a reminder that framing is not a neutral choice (Stecula & Merkley, 2019). A focus on COVID-19 deaths in January and February 2020 may have contributed to maladaptive behaviours (e.g., overbuying, committing racist acts toward marginalized populations), missing the opportunity to promote safety-enhancing activities and to counter misinformation in conjunction with health authorities (Basch *et al.*, 2020). Conversely, journalism focusing on positive messages and solutions (i.e., “constructive journalism”) uses effective debiasing techniques, can increase engagement, and may even help overcome some negative framing (Poort, 2018; van Antwerpen *et al.*, 2022).

6.2 Reducing Susceptibility

While valuable and necessary, reacting to and rebutting misinformation are costly and time-intensive activities (Ordway, 2020). Because fact checking and refutation take time, strategies that build individual resilience can limit the effects and spread of misinformation before a fact-checked response is available (Hameleers, 2022). Improving our competence in navigating an information ecosystem that contains misinformation can reduce our susceptibility to it and can be combined with fact-based refutation for greater effectiveness (Hameleers, 2022). Strategies that build resilience complement the more immediate techniques for addressing misinformation, and create a bridge to longer-term approaches for developing societal resilience and building institutional trust (Figure 6.7).

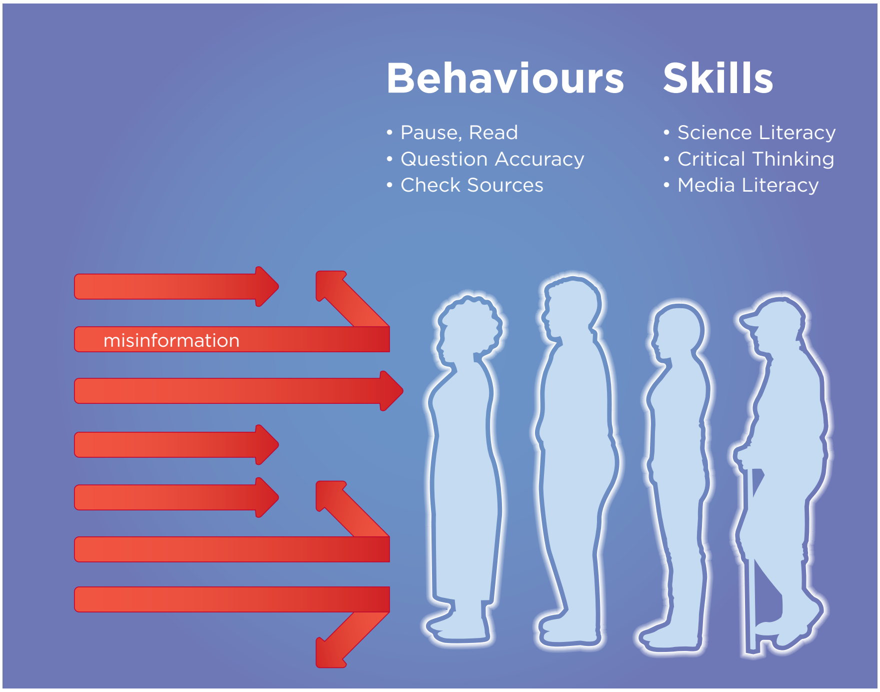

Behaviours
• Pause, Read
• Question Accuracy
• Check Sources
Skills
• Science Literacy
• Critical Thinking
• Media Literacy
misinformation

Figure 6.7 Resilience to Misinformation Through Skills and Behaviours

Effective media navigation can be taught by fostering critical thinking, media, and science literacy. Behaviours as straightforward as pausing to consider accuracy can help us better identify misinformation.

6.2.1 Education and Misinformation Detection

According to Edelman (2021), only one in five people in Canada practise good media engagement, such as avoiding echo chambers, verifying information, and not sharing unverified content. Schools, universities, government agencies, and social media platforms are among the groups trying to help expand digital literacy through education (Butrymowicz & Salman, 2021; Carr, 2021; Facebook, 2021). There is an ever-growing list of resources to help educate people, including games, curricula, and search tools (RAND, 2022).

Critical thinking, along with media and science literacy, can enhance misinformation resilience

A broad set of skills can be taught to improve misinformation detection. Critical thinking, science literacy, and media literacy are strategies that promote knowledge and skills development. Online content and misinformation pose a particular challenge, requiring new skills we did not need to use in previous media ecosystems (Jackson, 2021b). All people use a collection of tools to identify and refute misinformation, including prior scientific knowledge and critical thinking. For example, knowing that antibiotics cannot treat viral infections is enough to determine that "antibiotics prevent COVID-19" is a false claim; other pieces of misinformation require more sophisticated thinking (Puig *et al.*, 2021). Both open-minded and analytical thinking increase resistance to misinformation. Being reminded to think about the accuracy of what we read improves our discernment of the truth (Bronstein *et al.*, 2019). For example, accuracy prompts were found to increase misinformation detection in a U.S. study; however, they worked best for people who were more informed, analytical, and those with higher educational attainment (Epstein *et al.*, 2021).

All provinces and territories in Canada include media literacy in their school curricula (Hoechsmann & DeWaard, 2015). Digital literacy education has been shown to be effective at improving false or misleading news discernment when evaluating real-world news (Kim *et al.*, 2021). Teaching can focus on helping students develop media literacy skills, identify authentic information, evaluate evidence, and practise lateral reading (i.e., reading other sources to determine accuracy rather than examining one source deeply) (Hoechsmann & DeWaard, 2015; Polizzi & Taylor, 2019; COR, 2021). For example, the CTRL-F program, among others, focuses on lateral reading, which has been found to provide immediate and sustained skills in misinformation discernment (Breakstone *et al.*, 2021; Pavlounis, 2021). To aid educators in Canada, non-profits such as MediaSmarts and NewsWise are creating curricula alongside accompanying teaching resources (MediaSmarts, 2021; NewsWise, 2021). Other countries use similar educational approaches to combat misinformation (Box 6.3).

Box 6.3 A Finnish Approach to Combatting Misinformation

Since 2014, in response to coordinated Russian disinformation, Finland has been using a broad, multisectoral approach to prepare residents, students, journalists, and politicians to counter misinformation (Mackintosh, 2019). Finland drew on international expertise to develop its program. Though the country's approach aims to teach all people media literacy skills in order to increase the public's ability to detect misinformation, a central aspect of the plan involves kindergarten to grade 12 education (Mackintosh, 2019). Students are trained to detect, among other things, pseudoscience and climate change misinformation (Salomaa & Palsa, 2019; Henley, 2021). Finland scored highest in the European annual Media Literacy Index, which measures resistance to misinformation (Lessenski, 2021). State officials are also trained to recognize and combat fake news. A unique aspect of this response is that rather than addressing specific pieces of misinformation the Finnish Government focused on a narrative of Finnish identity — "who they are is directly rooted in human rights and the rule of law" (Mackintosh, 2019).

Cueing readers to think about the accuracy of information increases discernment and reduces the intent to share misinformation. For example, being prompted to evaluate a headline's truthfulness increases skepticism toward other, incorrect headlines (Calvillo & Smelter, 2020). Reflecting on the accuracy of headlines increases our ability to identify truthful information and improves the quality of the information we share by, for instance, reducing our tendency to spread COVID-19 misinformation (Pennycook *et al.*, 2021). Training students to combine simple strategies — including assessing the veracity and source of evidence and then comparing it to other evidence — creates durable misinformation detection behaviours after five weeks (McGrew *et al.*, 2019)

Educational settings provide an opportunity to inoculate people against misinformation by exposing them to the techniques used to spread it, in order to improve their skills in navigating media containing misinformation. One way to do this is through educational games. Bad News, for example, is a game that has participants use fake news techniques to spread misinformation in order to help them understand the tactics of those spreading misinformation, thus improving their ability to detect it (Basol *et al.*, 2020). Bad News has close to one million users worldwide, and has been shown to be effective at inoculating users against misinformation across different cultures and languages (Basol *et al.*, 2020). Tools are provided within the game to help educators use it in the classroom (Roozenbeek *et al*., 2020b). The game's creators are working with social media companies and governments to customize it for platforms and specific types of misinformation, such as extremism (Roozenbeek *et al*., 2020b). Other interactive games are being developed and deployed, such as Cranky Uncle and Fakey (Cook, 2020; Menczer, 2021). These types of games are being tested and employed by the WHO, government agencies, social media companies, and schools (Chang *et al*., 2020; Berman, 2021; Carr, 2021). However, the benefits of these games appear to decrease over time, suggesting a potential need for ongoing practice, as evidenced by the efficacy of booster sessions (Ivanov *et al*., 2018; Maertens *et al*., 2021).

Land-based education can build resilience to climate change misinformation

Educational pedagogies that focus on experience and exposure to build knowledge may be a valuable way to effectively combat misinformation. For example, land-based education can help increase awareness of climate change and motivate mitigation and impact reduction (Cherpako, 2019). Indigenous land-based education helps to increase understanding of the effects of climate change and boost support for collective climate change interventions among Indigenous and non-Indigenous people alike (GEEP, 2019). At the same time, land-based education can also support decolonization and the transmission of Indigenous knowledge and culture, thus promoting health and wellness among Indigenous people (Mashford-Pringle & Stewart, 2019; Ahmed *et al*., 2021). Though different from Indigenous land-based teaching in many important ways, other educational pedagogies that focus on experience of and exposure to nature are effective in aiding climate change education and improving mitigation efforts (Indigenous Climate Hub, 2021). Nature education can build a more empathetic relationship with the environment, which in turn contributes to prolonged environmental action (e.g., conservation, stewardship) (Palmberg & Kuru, 2000; Preston *et al*., 2021; Wadley, 2021). Beyond the benefits of broader and more holistic learning — and the promotion of environmentally friendly behaviour — outdoor learning is also effective at overcoming climate denial, resulting in consequential changes to one's environmental outlook (Grušovnik & Arzenšek, 2014).

6.2.2 Medium-Term Strategies to Harness Trust in Relationships

Practices used to increase resistance to misinformation over longer periods of time focus on building trust; medium-term techniques leverage existing trust within relationships. Using pre-existing relationships, such as those with family, friends, or healthcare professionals, can help deliver corrections. These relationships can also provide a source of regular interactions. Building trust through repeated interactions can be impactful, especially as single discrete interventions, such as those used in experimental settings, do not entirely correct misinformed beliefs, and their effects fade over time (Ivanov *et al.*, 2018; Paynter *et al.*, 2019). Among some groups, the sustained effectiveness of correction comes through more substantial interactions that either provide a more detailed explanation or that affirm correct responses (Swire *et al.*, 2017).

Trusted professional relationships can be used to address misinformation

One critical relationship for addressing health misinformation is between primary healthcare staff and patients (Arora *et al.*, 2020). Addressing patient concerns is an important aspect of combatting misinformation and building trust, but continually addressing new, scientifically unfounded concerns can drain limited resources (Yaqub *et al.*, 2014). Leveraging such relationships, however, requires extensive time commitments on the part of healthcare professionals, additional expertise in science communication, and — most importantly — continuous access to a physician (Yaqub *et al.*, 2014). However, physicians who are able to take the time to explain their recommendations to their patients can increase the acceptance of vaccines, even among patients who distrust experts (Brenner *et al.*, 2001; Dempsey & O'Leary, 2018).

More broadly, public health and medical professionals are well situated to use their relationships to repair the mistrust that arises from racial, social, and economic inequities; to address how these problems generate mistrust toward evidence-based health measures; and to alter the acceptance and sharing of misinformation (Jaiswal *et al.*, 2020). Addressing the inequities that risk worsening the effects of misinformation requires acknowledging racial discrimination, providing anti-racism training, and making research about the healthcare of marginalized people available (Tsai & Crawford-Roberts, 2017). Toronto's TAIBU Community Health Centre uses an Afrocentric approach to health promotion, which has improved influenza vaccination rates among people of African and Caribbean descent from 8% in 2013 to 53% in 2018 (Eissa *et al.*, 2021). This approach acknowledges that Black people's healthcare experiences are affected by anti-Black racism, provides culturally relevant resources, and is built around cooperation and collective input. Similarly, Black-led healthcare partnerships at Black Creek Community Health Centre increased COVID-19 vaccination rates from 5.5% (well below the national average) to 56.3% (equal to the national average) between April and May 2021 by using community ambassadors and reducing access barriers. Though these programs address much more than just misinformation, dispelling misinformation and providing accurate, quantitative COVID-19 information are essential to what they do (Eissa *et al.*, 2021).

Pre-existing relationships can be leveraged to limit the spread of misinformation

Inoculation techniques that protect us from misinformation can also improve community-oriented misinformation responses. People who are inoculated against misinformation share their techniques and learning materials with others (Ivanov *et al.*, 2015). When we are provided with counter-arguments against misinformation, we tend to become more reassured and more likely to advocate for our view, which reduces self-silencing and promotes a more robust discourse (Ivanov *et al.*, 2015; Cook, 2019).

In the United States, community behaviours that counter the spread of misinformation have been seen in the areas of vaccination and climate change. For example, exposure to influenza vaccine misinformation was negatively correlated with attitudes toward the vaccine among people who did not discuss the matter with friends and family, but no such effect of misinformation was found in people who reported having conversations about the vaccine with friends and family (Chan *et al.*, 2020). For politically sensitive topics such as climate change, many people feel they know too little about the issue to discuss it, whereas a substantial portion of people (26%) say it is too political to discuss (Leiserowitz *et al.*, 2018). When very few people talk about climate change, it reinforces the belief that others should not talk about it, leading to a communal silencing effect (Maibach *et al.*, 2016; Matthes *et al.*, 2017). But when counter-arguments to climate change denial have been shared, people are more likely to voice opinions, reducing self-silencing and encouraging discussion (Ivanov *et al.*, 2015; Cook, 2019).

6.3 Improving Societal Resilience

Misinformation is a global phenomenon to which nearly every person in Canada is exposed (Graves & Mantzarlis, 2020; Garneau & Zossou, 2021). It is not only widespread, but often coordinated and targeted, such as in the case of Russian anti-vaccine misinformation (e.g., Goldstein & Grossman, 2020; Serrato, 2020; Gordon & Volz, 2021). Addressing a problem as prevalent and purposeful as misinformation may require coordinated governmental and intergovernmental interventions that go beyond supporting individual skills development and the community measures discussed above. However, such interventions can rouse skepticism, which can be well founded among those whom governments have harmed, but is also found among those who ideologically oppose government action or believe in conspiracy theories (Enders *et al.*, 2020; Mosby & Swidrovich, 2021; Rutjens *et al.*, 2021; Sengupta & Massa, 2021).

6.3.1 Rebuilding Trust in Institutions

People with lower levels of trust in political institutions, as well as science- and health-based organizations, are more likely to be misinformed and harder to reach with corrections (Krishna, 2018; Agley & Xiao, 2021). Those with lower levels of trust in media or government tend to also rely on less accurate sources (Tripodi, 2021).

Trust is earned through transparent, effective, and equitable governance, with an engaged and informed populace

Our level of trust in specific institutions fluctuates in response to current events and practices, rising and falling throughout the pandemic for instance (Edelman, 2021). Trust in institutions was particularly valuable during the COVID-19 pandemic, as countries with higher levels of trust in government institutions, such as public health leadership, had lower infection rates (Dhanani & Franz, 2020; Elgar *et al.*, 2020).

Delivering timely and effective policy solutions is essential for building trust (Liu *et al.*, 2022). Focusing government solutions on tangible deliverables and positive, empathetic interactions may help foster trust. For example, we tend to have higher levels of trust in government services with which we regularly interact, such as those providing direct services or products (e.g., postal service, healthcare providers) (Deloitte, 2021). Institutions can also improve transparency and be more proactive in sharing information, which can help build trust and increase support for government policies (Kumagai & Iorio, 2020; Keefer & Scartascini, 2022).

Lack of trust among people in Canada results from many factors. Inequality and different levels of media literacy correlate with a public trust gap — those with higher incomes and higher levels of education are more trusting (Edelman, 2021). However, people with high incomes who are not well informed (i.e., who do not read widely, explore opposing views, or check information against multiple sources) exhibit lower levels of trust than those who are highly informed but have lower incomes (Edelman, 2022). A lack of positive media behaviours is also associated with vaccine hesitancy (Edelman, 2021). These findings point to the value of media literacy (Section 5.2) and access to high-quality information (Section 5.1) for rebuilding trust and preventing the harms of misinformation.

Inequity drives distrust, which can in turn decrease civic engagement (Uslaner & Brown, 2005). For instance, when coupled with systemic racism, inequity can amplify distrust through underrepresentation in leadership, governance, supports and services, and through over-policing (Kumagai & Iorio, 2020). Civic engagement increases transparency and accountability, which ultimately helps to foster trust in government. This is especially important for governments that collect race-based data. Evidence from the tax system indicates that incorporating equity (i.e., everyone paying their share) and fairness (i.e., administered with integrity) into policies improves trust in government (Kumagai & Iorio, 2020). Other characteristics correlated with lower trust include age (youth), racialized identity, and feelings of anxiety or depression, all of which may also indicate equity issues (Rainie & Perrin, 2020). Rebuilding institutional trust through transparent government, civic engagement, and tangible deliverables is a long-term exercise.

Respecting communities' traditions, needs, and knowledge contributes to meaningfully building trust

Recognizing cultural knowledge, traditions, and medical practices is key to strengthening relationships with communities that experience discrimination in accessing healthcare (Li, 2017). Culturally competent healthcare improves trust, satisfaction, and adherence to pro-health behaviours, such as instituting lifestyle changes, improving diet, and adhering to medication schedules (Tucker *et al.*, 2011). Conversely, stigmatizing traditional medicine and dismissing a patient's beliefs risk perpetuating mistrust in the system (Li, 2017).

There are many ways to use Indigenous knowledge alongside conventional medicine when approaching healthcare. Two-eyed seeing,[18] for instance, can include inviting traditional medicine into hospital settings and residency programs, or offering conventional medical practices in Indigenous clinics (Marshall & Bartlett, 2009; Redvers *et al.*, 2019; Redvers & Blondin, 2020). Culturally specific outreach in Indigenous communities can take many forms, such as: First Nations leaders sharing their vaccine experiences online, Indigenous doctors leading discussions in their communities about COVID-19 vaccines, inclusive clinical trial recruitment, and community-based planning programs (Tucker *et al.*, 2011; Atter, 2021; CBC Radio, 2021) (Box 6.4).

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[18] "Two-Eyed Seeing is the gift of multiple perspective treasured by many aboriginal peoples ... it refers to learning to see from one eye with the strengths of Indigenous knowledges and ways of knowing, and from the other eye with the strengths of Western knowledges and ways of knowing, and to using both these eyes together, for the benefit of all" (Bartlett *et al.*, 2012).

Box 6.4 Building Community Trust into Emergency Planning

The emergency planning and preparation procedures of Nisichawayasihk Cree Nation (NCN), a Manitoba First Nation, were highly successful in preventing COVID-19 cases, gaining community trust, communicating crucial medical information, and addressing the spread of misinformation early in the pandemic (Kyoon-Achan & Write, 2020). Joint decision-making saw healthcare professionals and community leaders working together to ensure that messages were consistent and community resources were accessed. Practitioners conducted traditional health practices to provide psychosocial and spiritual support, but these were modified to accommodate social distancing. In addition, mental healthcare was considered in the planning; a therapist and several counsellors were placed on alert, but they also proactively reached out to vulnerable people, such as Elders, the bereaved, those in palliative care, or people with predisposing conditions. After evaluating up-to-date COVID-19 public health information, the Chief and Council, along with public health officials, shared that information using a communication strategy designed to help secure public trust in authorities. They shared reliable information frequently to curb the effects of misinformation, which was already spreading through Facebook and other social media sites. Information was shared on the radio by the Chief in Cree and English, flyers based on reliable information sources were developed and distributed, and weekly memos were shared on the website and emailed to all staff (Kyoon-Achan & Write, 2020).

Where a lack of trust and social inequities compound the harms of misinformation, culturally specific healthcare can improve the well-being of people experiencing discrimination (Kyoon-Achan & Write, 2020). Adopting culturally conscious practices is not an indication of greater hesitancy or misinformation, rather it is an acknowledgment that misinformation is better addressed when cultural needs are met and trust is built (Kyoon-Achan & Write, 2020).

6.3.2 Government-Coordinated Outreach

Canada, like many countries, has expressed concerns about the prevalence and impacts of misinformation (GC, 2021c; UNGA, 2021). Regulatory strategies for digital content include increasing education, civic participation, transparency, and oversight, and working toward international regulation and enforcement (PPF, 2021). The Government of Canada has invested in a broad array of initiatives, including research funding and scholarships, transparency on election misinformation, improved cybersecurity, and the funding of digital media literacy projects to help address the problems of misinformation (PCH, 2020).

Coordinated community outreach can increase access to accurate medical information

Outreach and community engagement programs can help to mitigate the harms of science and health misinformation. Outreach programs can vary widely in size and reach, and can include community health centres, advocacy groups, professional networks, different orders of government, NGOs, media, and academic institutions (Gilmore *et al.*, 2020). A meta-analysis of literature examining community engagement in response to public health outbreaks outlined channels for engagement and intervention best used to foster successful community outreach. These channels included designing and planning community entry, building trust, and communicating about social or behavioural change and risk. Such channels were fundamental to reaching marginalized populations to create equitable responses and were most successful when they involved community leaders and organizations (Gilmore *et al.*, 2020).

The COVID-19 New Vaccine Information, Communication, and Engagement (CONVINCE) initiative and the public engagement case studies that are part of the IPCC Climate Outreach program are examples of international collaborations focused on community engagement and specific community needs (Larson *et al.*, 2020; IPCC Climate Outreach, 2021). The CONVINCE program includes "developing and implementing a coordinated plan to combat vaccine misinformation and disinformation" as one of its areas for action (Larson *et al.*, 2020). The IPCC case studies follow scientists as they apply IPCC climate communication principles around the world (IPCC Climate Outreach, 2021). These types of programs utilize the networks and credibility of their constituent organizations to effectively reach broad audiences, guide communication strategies, and provide up-to-date information (US DHS, 2012; Wahowiak, 2018).

Many countries have agreements with each other, or with online media companies, to combat misinformation

International coordination efforts can effectively prevent the spread of misinformation (EEAS, 2020). For example, the United Nations has partnered with Google to "ensure that factual, trustworthy content about climate is available to as wide a global audience as possible" (UN, 2021). As part of this partnership, Google will feature verified information in plain language with accompanying visuals to help people understand climate impacts and counteract misinformation (UN, 2021). The European Union funds fact-checkers and uses data from academic institutions, fact-checking organizations, and international partners to support an E.U.-wide rapid misinformation alert system that shares insights about disinformation campaigns and helps to coordinate responses (ECA, 2021; EEAS, 2021). In the United Kingdom, social media companies have committed "to the principle that no company should be profiting from COVID-19 vaccine mis/disinformation" (Gov. of UK, 2020). To coordinate efforts to combat COVID-19 misinformation at home, Canada — along with its G7 partners, the WHO, OECD, and other research institutions — launched a global vaccine confidence campaign that seeks to develop "evidence-based global standards to build confidence in public communication and address misinformation" (OECD, 2021). These arrangements show promise where agreement between governments and companies exists, but they are also constrained by a reliance on voluntary actions.

6.3.3 Curtailing Misinformation Through Legislation

Public policies, including legislation, can play an important role in mitigating the negative consequences of science and health misinformation and exist on a continuum from persuasive to coercive. Incentives (e.g., conditional cash transfers), disincentives (e.g., withholding benefits, taxing, restricting school enrolment), and compulsory mandates are other policy strategies to change people's behaviour without necessarily changing their views (Giubilini, 2019). For vaccine refusal or hesitancy caused by misinformation, financial incentives, vaccine mandates (e.g., childhood vaccines for school admission), or restrictions imposed on unvaccinated people (e.g., vaccine passports for restaurant or gym entry) attempt to increase vaccination rates and curb the spread of illness (Savulescu *et al.*, 2021).

Evidence suggests that incentives and penalties increase vaccination rates (Duch *et al.*, 2021); however, a meta-analysis of vaccine mandates found a wide range of parental opinions on their acceptability (Betsch & Böhm, 2016). Moreover, mandates for one vaccine may cause a backlash against other vaccines (Betsch & Böhm, 2016; Smith *et al.*, 2021). Because of the public's complex feelings about vaccine mandates, even among vaccinated people, careful consideration about the most effective means of persuading people, and which alternate protections could be put in place, is helpful (Lewandowsky *et al.*, 2022).

With respect to mitigating climate change in the face of misinformation, promoting individual actions, such as participating in energy conservation programs, can be improved by incentives (e.g., tax credits, affordable loans), whereas penalties in the forms of fines and taxes have been shown to change fuel consumption behaviours (Krause, 2009). However, strategies using penalties can provoke negative and defensive responses and often require complex monitoring and enforcement (Bolderdijk *et al.*, 2018). Other tools, such as taxing carbon or setting emissions standards, can improve environmental outcomes by changing industry practices (An & Sauer, 2004; Ghazouani *et al.*, 2020). One promising strategy is to make the sustainable choice the default option, as most people will stay with a default rather than take the time and effort to change options (Pichert & Katsikopoulos, 2008; Steg & Vlek, 2009). Collectively, strategies that mandate behavioural changes come with risks and ethical considerations related to potentially compelling someone to act against their beliefs.

Legislating transparency by mandating the disclosure or flagging of misinformation would discourage its spread

Approaches that mandate data transparency may decrease misinformation without prohibiting speech. Germany is considering requiring media intermediaries to clearly identify bots, and the sources of political, ideological, or religious advertisements, in order to facilitate transparency if misinformation is posted (Law Library of Congress, 2019). France and Germany require a visible way for users to report misinformation found online (National Assembly of France, 2018; Law Library of Congress, 2019). The European Union's *General Data Protection Regulation* (GDPR) introduced stricter rules for collecting and handling user data, coinciding with a decrease in disinformation (Bayoumi, 2021). By placing restrictions on the data needed to micro-target — that is, using data to advertise to an individual — the GDPR appeared to slow the spread of foreign disinformation (Bayoumi, 2021).

Also in the European Union, the *Digital Services Act* and the *Digital Markets Act* established rules and standards for the treatment of illegal online content, new transparency and traceability obligations, bans on deceptive practices, and rules for using personal data in targeted advertising (European Parliament, 2022a, 2022b). Though the purpose of these acts is broader than science and health misinformation, their measures may help protect people against online health misinformation (CEP, 2020). While banning micro-targeting may be difficult under Canadian law, transparency and the regulation of micro-targeting may be a way to limit the impacts of misinformation (Gaumond, 2020). In the United States, Google has already implemented a limited version of this technique (Google, 2022). Similar policies could be pursued to reduce the effects of misinformation as an alternative to censorship laws (Reppell, 2021).

Laws prohibiting misinformation would be legally limited and difficult to enforce

Canada does not have laws that explicitly prohibit the spread of science and health misinformation.[19] However, *Canada's Digital Charter* is a non-binding document that sets out online integrity and authenticity principles to protect against disinformation (GC, 2021c). Creating misinformation censorship laws may be ineffective or unenforceable for various reasons, including the challenge of setting out a legal definition of misinformation, as well as issues of detection and enforcement (Turk, 2020; Reppell, 2021). The Government of Canada has the authority to place limited restrictions on speech where necessary, in accordance with domestic and international legal obligations for the sake of the public good (GC, 1982; SCC, 1986, 1992; LOPRESPUB, 2020; Nasu, 2021; Vese, 2021).

There have been a growing number of foreign laws attempting to curtail misinformation, though their effectiveness remains to be seen (Yadav *et al.*, 2021). Australia, Denmark, and Germany all have some form of mandated removal of violent or dangerous online content (Gov. of Australia, 2019; Law Library of Congress, 2019). In 2017, Germany enacted strict enforcement of the removal of illegal content from social media (Koulolias *et al.*, 2018); however, this law has been criticized for placing the burden on companies to determine the legality of free speech and for not providing oversight for legal content that is incorrectly removed (Human Rights Watch, 2018). Like Canada, Denmark has narrowly criminalized disseminating election disinformation (GC, 2018; Law Library of Congress, 2019). France instituted laws criminalizing misinformation about elections or that can disrupt public order, but these laws have faced challenges and some parts have been found unconstitutional (Gov. of France, 2018; National Assembly of France, 2018; Breeden, 2020). In other countries, laws purported to combat misinformation are used to silence people and independent news media, in support of authoritarian practices (Sarpong, 2022). Misinformation laws have also been used to censor legitimate criticism and accurate reporting (Funke & Flamini, 2020; Reporters Without Borders, 2020; Institute for Technology and Society, 2021).

The legality and enforceability of anti-misinformation legislation in Canada are questionable (Gaumond, 2020). Some argue that strong freedom of expression protections in Canada would prevent the enactment of laws directly targeting speech, but laws targeting funding or advertising practices may have a sturdier legal foundation (Gaumond, 2020). Strong freedom of expression protections in Canada mean that pursuing non-prosecutorial approaches that protect against misinformation (e.g., cooperation agreements, media literacy programs) may be more likely to succeed (Turk, 2020).

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[19] Canada has, however, criminalized disseminating election disinformation (GC, 2018).

Using existing laws to prosecute purveyors of misinformation has had mixed success

Misinformation may fall under existing laws covering defamation, hate speech, consumer protection, or the abuse of government resources (Reppell, 2021). The success of this approach is dependent on how well a case fits the specific provisions of a law. For example, tort of civil conspiracy or civil fraud may provide relief for misinformation presented as part of contract negotiations, but civil fraud is hard to prove, in part because of the requirement to demonstrate intent to violate the law (Hoyano, 1996; Legal Information for Fraud Victims, 2017).

Attempts in other countries to regulate specific instances of misinformation in this way have often failed, illustrating the complexity and difficulty of this method (HCCC, 2010; Olszynski *et al.*, 2017). Australia has had partial success in litigating misinformation using existing laws. The New South Wales Health Care Complaints Commission (HCCC) determined that an anti-vaccine group, the Australian Vaccination Network (AVN), provided medical advice, which the HCCC had the authority to regulate (HCCC, 2010). The New South Wales Supreme Court upheld the authority of the HCCC, but the case was lost on the technical ground that the provision used by the HCCC to investigate the complaints required proof of direct harm, which was not provided (NSW Supreme Court, 2012). The New South Wales Office of Liquor, Gaming and Racing also revoked AVN's authority to fundraise, citing improper administration and a lack of contribution to public interests (Greene, 2010).

The legal path to dealing with misinformation is not always clear. Misinformation spread by Australian politician Clive Palmer is under investigation by Australia's Therapeutic Goods Administration (TGA) and the Australian Electoral Commission (Meade, 2021). However, the laws as written may not address much of the misinformation that Palmer has spread (Searle, 2021). Misinformation spread by another Australian politician may be protected as political communication, and is not covered by the TGA mandate; however, because the misinformation contained data from a TGA database, copyright law may be a path to legal recourse (Tsikas, 2021).

Similar legal actions have been taken to address climate change misinformation in more than 18 countries; hundreds of cases have been filed in the United States alone (Olszynski *et al.*, 2017). These cases have met with similar technical legal difficulties, a result of trying to fit misinformation into the current jurisprudence (Olszynski *et al.*, 2017; Gilmer & Voris, 2021). While such strategies may not be widely applicable, they can be used situationally, for example, as they were in addressing tobacco misinformation (Olszynski *et al.*, 2017). In Finland, two pro-Putin, anti-immigrant purveyors of misinformation were convicted of defamation, disrupting Russia's use of domestic proxies for international disinformation; this conviction was the first for a disinformation campaign in the European Union (Mackintosh, 2019). In Canada, anti-vaccine misinformation groups can initiate lawsuits to "intimidate, silence and/or bankrupt opponents" (recall Box 5.1); such lawsuits are called "strategic lawsuits against public participation" (SLAPP) (Butler, 2022). Anti-SLAPP laws, such as those in Ontario, provide an avenue to legal recourse against spurious lawsuits that may falsely legitimize and spread misinformation (Butler, 2020, 2022; Caulfield & Benedetti, 2022).

Adaptable frameworks may be needed to monitor the effectiveness of mitigation strategies in a dynamic misinformation environment

Policy experts in Canada and abroad suggest that monitoring compliance and efficacy is key to any misinformation policy that attempts to produce effective countermeasures (Grogan, 2020; PPF, 2021). Monitoring and evaluation of public health measures — including the effects of their responses to misinformation — is underway and should provide insights into how effective specific measures have been in various populations (Basha *et al.*, 2020).

Observing changes in public sentiment on social media can provide up-to-date information about the effects of misinformation on policy perception, as well as measure the effectiveness of different responses to that misinformation (e.g., Dicks *et al.*, 2021). To improve monitoring practices for interventions, empirical evaluation — including efficacy measurements, data collection, and data reliability — can be incorporated from inception (Breza *et al.*, 2021). In this framework, one metric for success is whether an intervention's benefits are greater than its costs, including unintended consequences (Breza *et al.*, 2021). As policies and strategies are implemented to address increasingly complex problems to which misinformation contributes, monitoring and evaluation are essential to achieving long-term objectives (OECD, 2020).

Defining and measuring the outcomes of successful strategies to combat misinformation are challenging tasks where data are complex and effects difficult to analyze — where algorithms promote content, or where content from a regulated platform can migrate to an unregulated one (Bunting, 2018). A flexible framework for policy implementation may be necessary to deal with adapting priorities and changing content. In such a framework, regulators define governance standards and objectives iteratively, which are to be followed by platforms that are responsible for measuring the problem, creating and deploying solutions, and reporting on effectiveness, after which regulators assess whether those platforms achieved the broader objectives. In situations where outcomes are not measurable, the government may determine a platform's success by assessing the quality of the rules put in place by companies (e.g., media and social media).

The criteria for judging the rules may include due process, fair application, and good governance practices. Maintaining these standards could help prevent market abuses, monitor algorithm bias, engage stakeholders, and verify data collection and transparency. These types of regulatory systems attempt to meet policy goals by balancing adaptability against other considerations, such as open information ecosystems, the interests of diverse user groups, and commercial incentives (Bunting, 2018).

7

Final Thoughts

7.1 A Critical Point in Time
7.2 An Opportunity for Action
7.3 The Challenge Ahead

Misinformation has become a defining issue of our time. In this age of crisis and anxiety, our need to find and act with a common purpose is juxtaposed against our vulnerability to suspicion, mistrust, and fear. Misinformation has been increasingly weaponized to refute the very idea of objective truth, erode the distinction between truth and falsehood, and leave us questioning what, if anything, we may share as a society. Some of us have been injured, and even died, from acting on misinformation about health products and services. Some of us have transmitted vaccine-preventable diseases to family and friends because misinformation skewed our risk perceptions, and some have lost trust and stopped participating in our civic institutions because misinformation undermined our understanding of the facts. Fortunately, most of us still trust our science and healthcare institutions, follow public health guidelines, and participate in our democratic processes. However, the threat misinformation poses to individual well-being and public policy is real and rising, and the evidence of its effects is increasingly apparent.

This report reflects the findings of a multidisciplinary expert panel assembled to answer the question:

What are the socioeconomic impacts of science and health misinformation on the public and public policy in Canada?

All people in Canada encounter misinformation, whether on social media, in the news, or from their family and friends. Misinformation is pervasive and deeply tied to issues of identity, ideology, and politics. As daunting as the problem is, the Panel stresses that inaction when it comes to mitigating the creation and spread of science and health misinformation will only compound existing harms and allow new issues to arise.

7.1 A Critical Point in Time

This report comes at a vulnerable moment in our history, when misinformation is proliferating at previously unseen rates due, in part, to the connectivity, accessibility, and evolving information environment found in the online world, as well as societal trends of declining trust, increasing polarization, and the delegitimization of our knowledge institutions. Moreover, ongoing and emerging environmental, health, and political crises disrupt our communities and societies, adding to our collective anxiety and uncertainty about the future. Anxiety increases our desire to find some degree of certainty and, too often, to assign blame. Misinformation can satisfy those desires by providing simple answers, uncomplicated villains, miracle cures, and reassurances that give us the feeling of control. This leaves us vulnerable to exploitation by bad-faith actors spreading misinformation for personal, political, and economic gain.

During the writing of this report, the Panel encountered an ever-growing body of political, scientific, and health misinformation, particularly relating to the COVID-19 pandemic, along with a rapid expansion of research on misinformation. These new studies, refinements, and findings fed dynamically into the Panel's deliberations throughout its work. While seeking to provide insight and analysis applicable to the impacts of science and health misinformation writ large, the Panel acknowledges that the economic, health, and societal impacts discussed in this report are neither exhaustive nor exact. Moreover, there is a general lack of data and analyses on the socioeconomic impacts of science and health misinformation in Canada specifically, which this report hopes to begin to address with the modelling work captured in Chapter 4. The Panel notes that data scarcity — particularly the scarcity of data that can speak to socioeconomic factors influencing the severity of misinformation's impacts, such as gender, race, culture, age, income, disability, and language, as well as their intersectionality — constitutes a substantial knowledge gap. However, a lack of specific data should not prevent action; the magnitude of the potential and realized impacts captured in this report is alarming and speaks to the need for urgent and cooperative action.

7.2 An Opportunity for Action

Science and health misinformation will always be a problem — we do not know everything about the world, and new evidence, ideas, and knowledge can change our shared understandings. Indeed, the process of science is by design self-correcting. While sometimes slow and not invulnerable to error, overstatements, and even fraud, science and evidence-based medicine move forward through practices of communication, collective scrutiny, and replication. Improvements to these practices — which could include incentivizing research that provides critical examination and replication of evidence, as well as better protection and support for researchers who identify concerns with the published literature — could lead to more rigorous, robust scientific and medical research and institutions, all of which are essential for building trust. Similarly, strengthening journalistic practices and revisiting incentive structures in news media could help foster more rigorous and informative science and health journalism.

An even bigger challenge exists in addressing science and health misinformation online. Anyone can create and post content online, the user base is growing, and new communication platforms launch every year. Even in the past five years, as efforts to combat misinformation on widely used social media platforms such as Facebook and Twitter have been deployed with some effect, new venues for misinformation sharing have emerged, including a proliferation of encrypted private messaging apps. Regulating the online information environment occurs at the tension between freedom of expression and censorship, and it is unclear where government oversight might best play a role. Existing legislation may be applicable to harmful science and health misinformation online, but the implementation, evidence requirements, and enforcement of those laws may be challenging to adapt to the online context.

Still, there are promising practices available to disrupt the uptake and spread of misinformation. Choosing social media platforms that enforce policies to identify, flag, and remove science and health misinformation can reduce our exposure. Asking users to pause and consider information sources and credibility before sharing can reduce misinformation spread. Supporting education and training that improves our digital literacy can make us more resistant to being fooled by fake headlines and dubious content.

7.3 The Challenge Ahead

The Panel recognizes that speaking up against misinformation, particularly online, often invites vitriol, harassment, and threats of violence. This adversarial environment points to broader societal challenges, such as increasing polarization, social fragmentation, and the growth of harmful ideologies that pit one group of people against the "other." Rising economic inequalities have been shown to correspond to a loss of trust, as well as the loss of feelings of community — that is, of shared circumstances and common fate. Such broader social forces, when compounded by a lack of transparency in addressing scientific uncertainty and poor-quality science and health communication, can further contribute to our collective susceptibility to misinformation.

Within this broader view, there is a demand to restore institutions, build trust, and establish new institutions where necessary. As part of these exercises, and as a response to the increasing polarization of society, the Panel stresses the importance of expanding common ground. At an individual level, most people are looking to do what is right for themselves, their family, and their community. Trust-building endeavours that expand beyond the community — such as improving access and delivery of social services, including mental healthcare, as well as addressing issues of economic inequality and systemic racism — are long-term efforts, with implementation and impacts measured across generations. However, addressing the problem of misinformation through such trust-building endeavours can complement or strengthen other efforts already underway to secure equity and equality for all people in Canada.

Science and health misinformation does not occur in a vacuum. It is a product of numerous social forces — some benign, some malicious — that intertwine and unfold in an evolving information environment. Public health, environmental, and social crises influence our ability to process and respond to information. Understanding the socioeconomic impacts of misinformation is messy and often impossible to isolate from impacts resulting from historical abuses, lived experiences, systemic racism, and persistent inequities. Yet, there is clear evidence that misinformation can cause substantial harm to individual, community, and societal well-being. The good news is that we have strategies and tools that can help combat the harms of misinformation, strengthen and build trust in our institutions, and boost our ability to recognize and reject the misinformation we encounter. The enormity of the misinformation problem can feel overwhelming and impossible, but we cannot afford to turn away. The future health and well-being of people in Canada, and around the world, depend on our recognizing and responding to science and health misinformation today.

Appendix A: The Panel’s Agent-Based Model

This appendix provides a full description of the model used to develop the health and cost estimates presented in Chapter 4. It is a stand-alone document, so some of the content included below duplicates content presented in the report.

A.1 Agent-Based Model

The Panel used agent-based modelling to simulate the evolving nature of the COVID-19 pandemic. Agent-based models are run in temporal cycles, allowing the incorporation of time-varying elements, in this case variation in COVID-19 incidence and vaccination coverage. The Panel’s model (Figure A1) simulated people in Canada aged 12 and over on a weekly basis from March 1 to November 30, 2021, covering two waves of the COVID-19 pandemic. Each week, the agents faced some probability of contracting COVID-19, and the corresponding health outcomes were modelled. The model was populated by one million hypothetical agents with heterogeneous underlying characteristics (age, sex, province/territory, vaccination status, and willingness to vaccinate). These characteristics were assigned proportional to the observed Canadian population as per Statistics Canada (2022a). Agents were either acceptant (willing) or hesitant (reluctant or refusing) to receive the COVID-19 vaccine. The amount of misinformation in the population affected the proportion of people willing to be vaccinated. The model was built in Python Version 3.7.13.

The model simulated changes for each week between March 1 and November 30, 2021. The agents were divided between an unvaccinated and vaccinated group. Within each weekly cycle, agents could become infected proportional to their probability of contracting COVID-19 based on their vaccination status. Upon infection, agents’ infection resolved at home, in hospital, or in the ICU, and then they either recovered or died based on the likelihood of those outcomes for those agents. The likelihood of severe disease and death was greatly reduced by vaccination. Agents that recovered from COVID-19 subsequently returned to the broader population group for future time periods in the model.

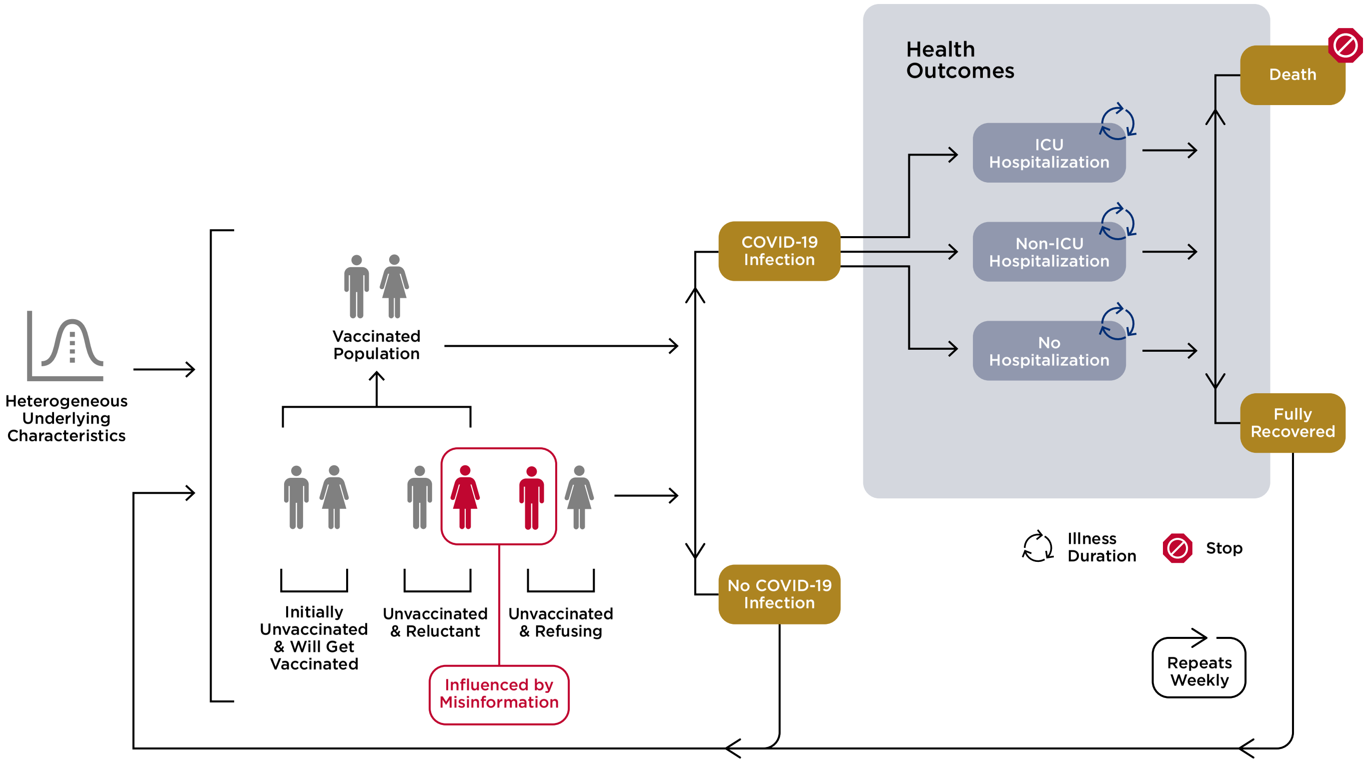
Heterogeneous Underlying Characteristics
Vaccinated Population
Initially Unvaccinated & Will Get Vaccinated
Unvaccinated & Reluctant
Unvaccinated & Refusing
Influenced by Misinformation
COVID-19 Infection
No COVID-19 Infection
Health Outcomes
ICU Hospitalization
Non-ICU Hospitalization
No Hospitalization
Death
Fully Recovered
Illness Duration
Stop
Repeats Weekly

Figure A1 Agent-Based Model Flow Diagram

The model is populated with hypothetical agents with heterogeneous underlying characteristics. The agents are divided among unvaccinated and vaccinated groups. Agents can either be infected or not; if they are infected, they can then recover at home, be hospitalized, or be admitted to an ICU. Ultimately, these agents will fully recover or die. The probability of these infections and outcomes varies with vaccination status.

A.2 Model Choice

A range of agent-based models have been used to study COVID-19 (Kerr *et al*., 2021; Wang *et al*., 2021). This type of model facilitates dynamic simulations, where heterogeneous individual "agents" (in this case, simulated people in Canada) are given characteristics that influence their outcomes (Macal & North, 2010; Conte & Paolucci, 2014). Agent-based models allow for a combination of static and time-varying data and thus enabled the Panel to work with the best available data (Tracy *et al*., 2018). The Panel used reported epidemiological data, which capture all the underlying dynamics that played out in Canada between March and November 2021 (e.g., masking, social distancing, lockdowns, personal behaviour). In this model, the number of cases varies among scenarios because the incidence rate is different between vaccinated and unvaccinated populations, and misinformation alters how many of the agents are vaccinated. The Panel's model did not incorporate a transmission model because there was a lack of data on the impact of social distancing and masking. Instead, given the model was built from real-world data, the results have accounted for social distancing and masking indirectly through the incidence rates. In practice, vaccinated people are less likely to spread COVID-19 to others (Fisman *et al*., 2022); since reduced likelihood of transmission is not captured in the model, the results are conservative.

A.3 Baseline Model

A baseline model was first simulated to match the observed health outcomes during this period of the COVID-19 pandemic in Canada (i.e., vaccination levels, cases, hospitalizations, ICU admissions, and deaths). Agents became vaccinated at the reported weekly rates based on real-world data by age and province/territory (PHAC, 2022).[1] Around 85% of the population was considered accepting of vaccination in the baseline model, based on a large national survey by Statistics Canada (2022b). The remainder of the population was separated equally into reluctant and refusing populations based on Abacus Data survey results (Anderson, 2021).

Historical weekly reported cases of COVID-19 were then used to estimate the number of individual agents in the model that were infected with COVID-19 each week (Radio-Canada, 2022). Infected agents could progress to hospital treatment, be admitted to ICU, or remain at home. Agents faced different probabilities of being infected by COVID-19, hospitalized, admitted to the ICU, or dying, based on their age, sex, province/territory, and vaccination status. Hospitalizations were estimated using a hospitalization risk ratio for vaccinated versus unvaccinated patients from the Public Health Infobase; these were distinguished by age based on the risk of hospitalization among people over 65 years of age, which was seven to nine times higher than among people younger than 65 (CIHI, 2022; GC, 2022) ICU estimates were derived as a province/territory-specific proportion of hospitalizations, based on real-world data (CIHI, 2022; Radio-Canada, 2022). Deaths were estimated using a case fatality rate for vaccinated versus unvaccinated people from the Public Health Infobase; again, these were distinguished by age based on the risk of death among those over 65 years of age, which was 90 to 120 times higher than among younger populations (CIHI, 2022; GC, 2022). Based on an average duration of illness of just over 12 days (CIHI, 2022), a two-week lag was modelled between the time agents became infected and were subsequently hospitalized and/or had died.

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[1] Because the baseline model was constructed on observed vaccination rates, vaccine mandates were captured in the model to the extent that they were influencing individual decision-making.

The resulting outcomes were tracked weekly in numbers of modelled patients recovering fully or dying. Cases of hospitalizations and deaths were validated by comparing the rates of hospitalizations and deaths for older vs. younger populations in the model with Canada's real-world data. Data on unit costs of hospitalizations and ICU stays by province and territory came from the Canadian Institute for Health Information (CIHI, 2022).[2] All data sources are listed in Appendix B. The end results across one million agents were scaled to the Canadian population in order to estimate the population-level impact.

A.4 Misinformation Scenarios

The costs of COVID-19 misinformation were examined through hypothetical scenarios. In these scenarios, fewer agents were simulated to be influenced by misinformation compared to the baseline, meaning more agents were characterized as vaccine accepting and would therefore receive a vaccination at some point in the model. Essentially, these scenarios removed the influence of misinformation to different degrees. Agents willing to be vaccinated became vaccinated as soon as a dose was available to them. Simulated vaccinations started with the oldest age group (80+), then moved to younger age groups once all agents willing to be vaccinated among the older age group were vaccinated.

The Abacus Data summarized in Table A1 was used to estimate the share of the hesitant population influenced by misinformation. These data were chosen because they offer two different versions of beliefs in misinformation, providing a range of possible misinformation impacts on COVID-19 vaccination rates in Canada (Box 4.1 in the report describes other corroborating data). The first estimate of the level of misinformation among the population was the proportion of survey participants who agreed that COVID-19 is a hoax and/or exaggerated. The second estimate was the proportion who agreed that vaccines cause many problems that are covered up. The Panel agreed that these distinct beliefs among vaccine-hesitant populations could be the result of different lines of misinformation about COVID-19.

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[2] The cost of Canada's vaccination campaign, including the purchase of vaccine doses, was not considered in this analysis. The decision to procure and offer a vaccine to all people in Canada was a policy choice made before the model period (Rastello & Bolongaro, 2020).

Table A1 Misinformation Beliefs Among Vaccine-Reluctant and Vaccine-Refusing Populations

		Population Segment Who Are	
		Vaccine-Reluctant	**Vaccine-Refusing**
Percent of the Population Number of people in Canada (millions)		**7%** (2.1)	**7%** (2.1)
Percent (of 2.1 million) who agree with the statement	**COVID-19 is a Hoax/Exaggerated**	**34%**	**73%**
	Vaccines Cause Many Covered-Up Problems	**66%**	**85%**

Data Source: Abacus Data (2021), as cited in Anderson (2021)

Recognizing the complexity of hesitancy and misinformation, the Panel used these data to construct three hypothetical scenarios:

(i) **No Hoax:** The belief that COVID-19 is a hoax/exaggerated was eliminated and all those who reported this belief in the baseline model were assumed to be vaccine-accepting in this scenario.

(ii) **No Cover-Up:** The belief that vaccine harms are being hidden was eliminated and all those who reported this belief in the baseline model were assumed to be vaccine-accepting in this scenario.

(iii) **Full Vaccine Acceptance:** The entire population was assumed to be vaccine-accepting in this scenario.[3] In this scenario, everyone chose to be vaccinated as soon as they were able, so the case, hospitalization, mortality, and costs data represent the most optimistic scenario of what could have been achieved in Canada through full vaccine uptake (subject to supply constraints).

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[3] Analysis from Ontario suggests that a very small number of people in Canada qualify for a medical exemption from COVID-19 vaccines due to either a severe allergy to vaccine components or risk of myocarditis (MOH, 2022). Valid medical exemptions are estimated to apply to between 1 and 5 out of 100,000 individuals (Rocca, 2021; Crawley, 2022), and are thus not incorporated in the model, since they would not make a significant difference in the results.

First, the baseline model was simulated, aligning with Canadian real-world data. Then, the three hypothetical scenarios were simulated, wherein more agents were willing to be vaccinated. The increased amount of the population simulated to be willing to vaccinate in the No Hoax and No Cover-Up scenarios are described in Table A1. All reluctant and refusing populations were simulated to be vaccinated in the Full Vaccine Acceptance scenario. To calculate the impact of misinformation, baseline model results were subtracted from results of each scenario in terms of number of vaccinations, cases, hospitalizations, ICU visits, deaths, and hospitalization costs.

In the Panel's view, the No Hoax and No Cover-Up scenarios represent unambiguous and severe instances of misinformation. In contrast, the Full Vaccine Acceptance scenario presents an upper bound by looking at what the outcomes might be if all people accepted vaccination as soon as a vaccine was available. This upper bound helps to benchmark and interpret the results of the two misinformation scenarios. The three model scenarios offer a range of the extent to which the Canadian population was misinformed about COVID-19 vaccines in 2021.

The model estimated the impact misinformation may have had on people's vaccination decisions, and the resulting rise in burden of illness and hospitalization costs, by age group, province/territory, and sex. By comparing the baseline model and hypothetical scenarios, it was then possible to estimate the differences in health outcomes across scenarios, producing a share of the population for whom misinformation is *a contributing factor* to the choice not to vaccinate. The model does not establish a causal relationship between misinformed beliefs and vaccination, but rather assumes this causal effect based on established literature reviewed in Section 4.1 of the report.

A.5 Key Model Parameters and Assumptions

A.5.1 Age Range

The model focused on the population in Canada aged 12 and above. Children 11 years of age and younger were excluded because they were not eligible for vaccination during the period in which the model was run.[4] The 12 to 17 years age group was included in the model because vaccines were available to this group, and parental misinformation was likely to contribute to choices not to vaccinate youth.

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[4] Cases and hospitalizations among people aged 11 and under were included in the simulations due to a lack of disaggregated data but did not factor into the results. The baseline results were subtracted from each of the scenarios to estimate the impact of misinformation. The difference is attributable to vaccinated people aged 12 and over, because cases and hospitalizations of children aged 11 and under are cancelled out in the subtraction.

A.5.2 Time Period

The model covered the period between March 1 and November 30, 2021. This period was chosen based on COVID-19 vaccine availability in Canada, the availability of vaccine administration data, as well as completeness and compatibility with other necessary COVID-19 data (e.g., cases, hospitalizations, deaths). The model was not extended past November of 2021 to give the Panel adequate time for report drafting and peer review. The Panel notes that this period preceded the spread of the Omicron variant. Given that vaccine efficacy was substantially diminished for this variant (Lauring *et al.*, 2022), additional data inputs would have been required for meaningful analysis of winter 2021–2022.

A.5.3 Vaccine Administration

In Canada, supply was the limiting factor driving vaccination rates through to mid-2021 (BBC News, 2021; Raycraft, 2021). The Government of Canada prioritized giving out more first doses to more people by withholding second doses while procurement of COVID-19 vaccines was initially slow, and because a single dose provided a high degree of protection (Skowronski *et al.*, 2021). Vaccine eligibility was opened to all elderly populations by mid-February in the territories and by March in most provinces (PHAC, 2022). Between mid-April and mid-May, many provinces and territories made the first dose of COVID-19 vaccines available to all adults. By early June, there were not enough adults seeking first doses, so many provinces started giving out second doses (PHAC, 2022). Supply was no longer a constraint by mid-July; at this stage, vaccine hesitancy stalled progress in further increasing overall vaccination coverage (Aiello, 2021a, 2021b). The model is therefore built around two distinct stages: the limited supply stage in the spring and the unlimited supply stage in the summer and autumn.

Spring Constrained Supply Stage

The first stage ran from the beginning of March until mid-July 2021. During this stage, the model focused on administration of the first vaccine dose. This is because the long delays in administration of a second dose were due to policy rather than hesitancy. Not all available doses were administered throughout this period. This is partially attributable to logistical and capacity constraints (e.g., D'Mello, 2021; Gilmore, 2021b; Woodward, 2021), and partially attributable to hesitancy.

During this period, there was ample capacity in Canada to vaccinate people aged 70 and older with a first dose. However, not every person in that age group chose to be vaccinated. Table A1.2 shows the percent of individuals in this age group who were offered the vaccine but did not receive it. These data are used to estimate the number of vaccination slots open in the system that were not filled, and thus the number of extra vaccines that were available in that period but not used (i.e., excess system capacity). This creates an upper bound on the number of additional doses that could be administered in the model. In the model scenarios, eligible and willing people were vaccinated as soon as there was vaccine availability (on a weekly basis).

Table A2 Vaccine-Hesitant Older Populations in Canada by Mid-May 2021

Province/Territory	% of Unvaccinated People Aged 70+
Alberta	17
British Columbia	13
Manitoba	10
New Brunswick	14
Newfoundland and Labrador	12
Northwest Territories	7
Nova Scotia	13
Nunavut	14
Ontario	15
Prince Edward Island	11
Quebec	9
Saskatchewan	13
Yukon	7

Data Sources: Radio-Canada (2022) and StatCan (2022a)

Summer–Autumn Unlimited Supply Stage

The model's second stage ran from mid-July to the end of November 2021. Recognizing the widespread availability of vaccines during this stage, the model used full vaccination (two doses) as a measure of vaccine acceptance. In the model scenarios, vaccination supply was opened up during these months to allow for as many people as possible to become vaccinated (limited to the highest weekly number of vaccinations administered per province or territory). The model did not factor in boosters, which is appropriate given the time period considered.

A.5.4 Hospitalization and ICU Costs

The model estimated the treatment costs for COVID-19, capturing acute costs of illness in terms of hospitalizations and ICU visits by province/territory. The cost estimates represent only costs covered by the hospital and exclude physician fees (CIHI, 2022). Cost estimates were unavailable for Nunavut, Quebec, and Prince Edward Island; the national average was used in those instances.

A.5.5 Uncertainty in Model Inputs

Probabilistic sensitivity analysis was performed by ranging COVID-19 incidence and vaccination rates using a beta distribution, and the costs of hospitalization and ICU visits using a gamma distribution, with a 10% range around the mean. A one-way sensitivity analysis was also conducted to examine the impact of COVID-19 incidence, hospitalization rates, ICU rates, and costs of hospitalizations and ICU stays on model outcomes. By ranging each of these key variables by 10% above and below the mean, model results showed a similar impact of each of the variables, because hospitalizations, ICU visits, and associated costs change proportionally with COVID-19 incidence.

A.6 Model Limitations

All models are inherently limited by data availability and the quality of the data used to derive model parameters. The influence of misinformation may vary widely among populations, but data were not available to break down the influence of misinformation by province/territory, sex, or age. Data on misinformed beliefs and vaccination status across demographic characteristics of the population could not be obtained, so overall estimates were used. In the model, the contribution of misinformation to vaccine reluctance and refusal was a fixed share across provinces/territories and over time. In practice, differences in policies and public health messaging also contributed to vaccination choices and adherence with other public health measures.

Epidemiologic data breakdowns by race, socioeconomic status, and rural-urban divides were not available for Canada. As a result, it was not possible to analyze the contribution of misinformation to the costs of vaccine hesitancy among different groups. The lack of collection and open dissemination of these data obscures problems of inequity and risks amplifying equity issues by failing to identify the unequal burden faced by racialized and other minoritized people. Relying on a fixed incidence rate also obscures problems of inequity. In practice, racialized and other minoritized groups faced differential risks of contracting COVID-19 (City of Toronto, 2022).

A series of data limitations make the model results conservative:

- Cases, hospitalizations, and deaths are likely underreported (Moriarty *et al.*, 2021; StatCan, 2022c).
- Other direct health costs, including outpatient medication, physician compensation, and long COVID costs, were not available at an appropriate quality or resolution to be included in the analysis.
- Quality of life impacts associated with COVID-19 illness are excluded from these estimates.
- Wider societal costs, including those associated with delayed elective surgeries and other curtailed healthcare services, lost wages, and productivity declines, were also not available in a way that could be reliably incorporated into the model.

Availability of more granular data would facilitate further analysis to examine demographic differences and additional costs.

Appendix B: Model Inputs

Variable	Source	Timeframe	Heterogeneous Variables Breakdown
COVID-19 Cases	Compiled by Radio Canada (2022)	Daily, March – December 2021	Province/territory
Risk of COVID-19 Hospitalization and Death for Vaccinated vs. Unvaccinated Populations	Public Health Infobase (GC, 2022)	Total as of January 4, 2022	
Non-ICU Hospitalizations	Compiled by Radio Canada (2022)	Daily, March – December 2021	Province/territory
ICU Hospitalizations	Canadian Institute for Health Information (2022)	Total as of October 9, 2021	Used for age and sex
	Compiled by Radio Canada (2022)	Daily, March – December 2021	Province/territory
Deaths	Canadian Institute for Health Information (2022)	Total as of October 9, 2021	Used for age and sex
	Compiled by Radio Canada (2022)	Daily, March – December 2021	Province/territory
Vaccination Coverage[5]	Public Health Infobase (PHAC, 2022)	Weekly, March – December 2021	Partial and full vaccination by province/territory, age, sex
Willingness to Vaccinate	Statistics Canada (2022b)	Three time periods: March to April, June to August, September to mid-November 2021	Province, age, sex
Vaccine Hesitancy Attributable to Misinformation	Maclean's (Anderson, 2021)	Single time point, August 2021	
Population Data	Statistics Canada (2022a)	Census data, 2021 Census	Province/territory population, age, sex (12+)
Life Expectancy	Statistics Canada (2015)	Reference Period 1991 – 2006	By age group, ages 25 to 90 (5-year intervals)
Cost of Hospitalization	Canadian Institute for Health Information (2022)	April – December 2021	Province-level cost (excluding QC, PEI, NWT)
Cost of ICU Hospitalization	Canadian Institute for Health Information (2022)	April – December 2021	Province-level cost (excluding QC, NU, NWT, YT, PEI)

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[5] Provincial and territorial data on doses administered appear to include data reported on doses administered in Indigenous communities from Indigenous Services Canada.

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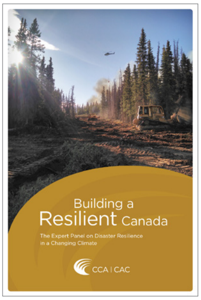
The assessment reports listed below are accessible through the CCA's website (www.cca-reports.ca):



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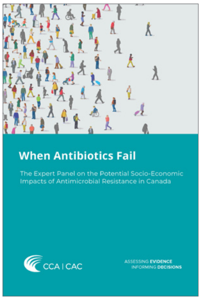

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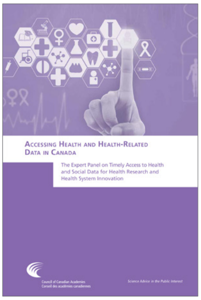

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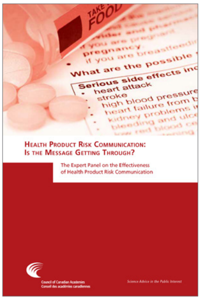

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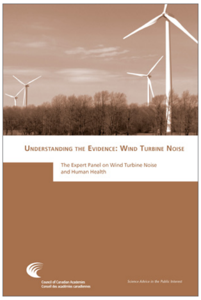

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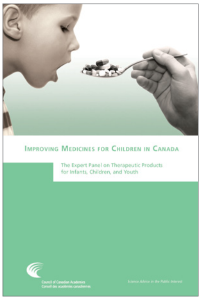

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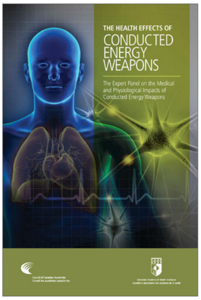

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