Canadians' Anti-Masking Attitudes on Twitter

During the First Wave of the COVID-19 Pandemic

by

Yekta Sharafaddin-zadeh

A thesis submitted in partial fulfilment of the requirements for the degree of

Master of Science

Department of Psychology

University of Alberta

Abstract

Several countries recommended universal masking as a preventive health measure to contain the spread of COVID-19 before public health officials in Canada started endorsing public mask wearing. In the first wave of the COVID-19 pandemic in Canada, public use of face masks was controversial. Many Canadians took to social media (e.g., Twitter) to debate the use of face masks— who should wear which types of masks, when and how often, and why. In this study, we combined computing and social science techniques to extract likely Canadian tweets and qualitatively study Canadians' anti-masking attitudes during the first wave of the pandemic (January to September 2020). We discuss some beliefs that may have contributed to the emergence of anti-mask sentiment by highlighting five major themes in the Twitter discourse (i.e., face mask efficacy, personal discomfort, perceived risk, rights and freedoms, and culture clash), and also ways that some Canadians attempted to synthesize these contrasting views. Our findings inform public health messaging and strategies for dealing with misinformation during health crises, and point to the role prominent social media figures can play in fostering (or not) a culture of open mindedness.

Keywords: COVID-19, Twitter, social media, face masks, Canada

Preface

Some of the research conducted for this thesis is part of a larger COVID-19 research program led by Professor Kimberly A. Noels at the University of Alberta. The research team includes Professor Nigel M. Lou at the University of Victoria, and faculty members and students at the University of Alberta, including Dr. Heather Young-Leslie, Dr. Denilson Barbosa, doctoral candidate Doris Zhang, and Master student Veronica Slam (now at the University of Waterloo). The research was funded by a COVID-19 grant from the Canadian Institute of Health and Research (CIHR) to Kimberly A. Noels (Principal Investigator) and Nigel Mantou Lou (Co-Investigator). The computer science analyses were conducted by Veronica Slam under the supervision of Professor Denilson Barbosa. I conducted the literature review, thematic analysis, and the manuscript composition, and I collaborated with Veronica Slam on the topic modeling. Professor Kimberly Noels supervised the design and analysis of the research, and the drafting of the manuscript. Heather Young-Leslie, Nigel Lou, and Yin Shan Doris Zhang were consulted throughout the research, and they reviewed early drafts of this document.

Dedication

I dedicate this work to my mother and father, Mojgan and Naser, to show appreciation for the sacrifices they have made to fulfill their vision of a free, happy, and healthy life for my siblings and me when we immigrated to Canada.

Acknowledgments

First and foremost, I would like to sincerely thank Dr. Kimberly A. Noels for being my supervisor. Thank you for believing in me, supporting and guiding me through difficult times, and always being in my court. I have truly grown immensely as both a researcher and an individual under your supervision. This great experience I have had as a master student (during COVID also) could not have been possible without you. I would also like to thank the External Examiner, Dr. Sarah Moore, the chair of the examining committee, Dr. Norman Brown, and the members of the supervisory committee, Dr. Elena Nicoladis and Dr. Alona Fyshe, for their contributions, time, and accommodations for my academics. I would also like to thank the COVID-19 research team, including Dr. Nigel Mantou Lou, Dr. Heather Young-Leslie, and Doris Zhang, as well as Dr. Denilson Barbosa and Veronica Slam. I would like to thank everyone in the Intercultural Communication Lab. I acknowledge the Social Sciences and Humanities Research Council (SSHRC), which financially supported me with a Canadian Graduate Scholarship-Master's to do this project. I would like to thank all my friends, and especially Raman K. Kalher, for their support through these years. Finally, I would like to thank the people that I forced into reading my papers the most—my parents. Thank you for all that academic feedback and discussion but more importantly, thank you for being my rock.

Contents

Canadians' Anti-Masking Attitudes on Twitter During the First Wave of COVID-19

Wearing face masks has become a common preventive health behaviour to limit the spread of the COVID-19 pandemic. Despite the research that suggests wearing face masks can effectively reduce droplet and airborne transmission of SARS-CoV-2, adopting the use of masks has been controversial. Numerous debates are recorded in mass and social media, including on Twitter. Moreover, the public health restrictions designed to curb the spread of the virus, including lockdowns, quarantines, and mask mandates, were viewed by some as antithetical to our democratic and individualistic way of life, which likely fuelled several anti-mask and lockdown protests, including those in Canada. Studying Canadians' attitudes toward face masks is crucial in a health crisis, since mask-compliance is necessary to limit the spread of communicable diseases. Furthermore, a nuanced analysis of these attitudes, focused on anti-masking sentiments, can better inform intervention strategies aimed at reducing mask noncompliance.

In this study we examined Twitter data because we believe that Twitter provides researchers access to a large exchange of extemporaneous and varied opinions (Schools, 2019). Much of the current research examining discourse on Twitter primarily uses computer science techniques to reveal prevalent topics (Adamic & Glance, 2005; Bozdag et al., 2014; Bravo et al., 2015; Conover et al., 2011; Del Vicario et al., 2017b; Garcia et al., 2015; Lorentzen, 2014; Medaglia & Zhu, 2016, 2017; Williams et al., 2015). While such large-scale approaches can inform us of prominent topics, they may not be particularly helpful to researchers who want to understand users' perceptions and attitudes, because they tend to be content-neutral. Many researchers have suggested that textual analysis of Twitter data would likely assist in identifying ideologically distinct communities (Gruzd & Roy, 2014; Hemphill et al., 2016), antagonistic

narratives (Bode et al., 2015; Marozzo & Bessi, 2018; Turetsky & Riddle, 2018), the emergence of extreme views (Garimella et al., 2016; Romenskyy et al., 2018; Weber et al., 2013), and polarized online sentiment (Alamsyah & Adityawarman, 2017; Borge-Holthoefer et al., 2015; Finn et al., 2014; Gruzd & Roy, 2014; Merry, 2016; Primario et al., 2017). As such, we extend understanding of face mask attitudes during COVID-19 through a nuanced reading and interpretation of Twitter data from the first wave of the COVID-19 pandemic.

We seek to answer several questions through this analysis. How has anti-masking sentiment emerged and evolved in the Canadian face mask discourse? What types of arguments do people use to justify their stance regarding facemasks? To contextualize the thematic analysis, we discuss the scientific, social, and cultural climate around COVID-19 in Canada.

Anti-making Sentiment During COVID-19

Soon after public health officials began recommending the use of masks in May 2020, only two-thirds (65%) of Canadians reported wearing a mask in public spaces, a number that increased to 97% by September 2020 (Statistics Canada, 2020). It is possible that this high percentage is inflated; the Pew Research Centre in the United States also found a relatively high self-reported mask use (74.1%), but only 44% of the participants reported that they saw others wearing masks in the community, suggesting that the high self-reported rates may be subject to social desirability bias (Centers for Disease Control and Prevention, 2020). Despite the possibility of exaggerated numbers, the point remains that the majority of Canadians support and use facemasks as one way to curb the spread of COVID-19.

Despite this widespread acceptance, there remained a portion of the Canadian population that did not endorse facemask use during this time period. Anti-masking sentiment poses a

challenge to public health officials in increasing public compliance but also poses a threat to the community. As such, investigating these attitudes can inform public health strategies. A review of information gathered from journalists, public officials, and other sources shows there are a variety of arguments against mask requirements. One claim has been that the data supporting the use of masks to prevent the spread of COVID-19 is insufficient (Greenhalgh, 2020). A group of doctors sent a retraction request letter to the Editorial Board that published Zhang and colleague's (2020) study—which supported mask wearing—on the grounds that making claims that mask-wearing is the best method to slow the spread of COVID-19 implies that other non-pharmaceutical interventions are ineffective (Meta-research Innovation Center at Stanford, 2020). Furthermore, some authors have also expressed concern about the public's consistent and proper wear of masks and believe that people are likely to touch their mask and potentially self-contamination (Greenhalgh, 2020). Other researchers believe that trials of mask wearing show that the simple act of mask-wearing can make people feel safe and so they may disregard other well-proven preventive behaviours such as hand washing and social distancing (Xiao et al., 2020).

Another claim is that mask mandates restrict freedom, are an overreach of government power, and are unconstitutional (Ladapo, 2020; Mccain, 2020; Warth, 2020). For instance, Flood and colleagues (2020) discuss some of the impacts the pandemic and government officials' pandemic response efforts have had on civil liberties. When discussing the impact of mandatory masking, they make the argument that these laws do not violate the Canadian charter rights. Yet, they highlight that governments should still consider liberty interests when developing policies. The intensity with which people believe that masking mandates infringe on basic civil rights is

underscored by several reports of anti-masking rallies calling for “freedom of choice” across Canada (Bogart, 2020).

Many studies have also examined the role of political orientation in mask-wearing attitudes and have reported that those leaning to the right on the political spectrum often have less favourable views of masks (Allcott et al., 2020; Gadarian et al., 2020; Pennycook et al., 2021). Furthermore, Merkley and Loewen (2021) found that a distrust of experts and intellectuals and COVID-19 risk perceptions played a role in shaping anti-masking attitudes.

Much of the literature on face mask use has been conducted in the context of the United States and/or uses traditional social science methods (e.g., questionnaires, surveys, and focus groups) to understand people’s beliefs and attitudes concerning masks (Badillo-Goicoechea et al., 2021; Dillard et al., 2021; Zhang et al., 2021; Zimmermann et al., 2021). These studies can be limited in sample size and generalizability and so should be replicated using other methods. As such, studying social media data such as Twitter gives us another tool to understand people's extemporaneous opinions and attitudes towards face masks and mask wearing.

Shifts in Public Health Recommendations of Mask Use

Another contributing factor to the mask controversy was Canadian public health authorities’ initial shifts in mask recommendations. From January 2020 until April and later in June 2020 respectively, the Canadian Chief Public Health Officer, Dr. Theresa Tam, and the World Health Organization continued to recommend against public mask use, stating that masks could induce a false sense of security, reduce compliance with other preventative measures (i.e., handwashing and social distancing) (Maher, 2020), and highlighted the risk of self-contamination. Later when the Centers for Disease Control and Prevention began to recommend the public use of face masks in April 2020, the mask debate not only remained a controversial

topic among Canadians, but many also grew skeptical of public health recommendations (Zhang et al. 2021). Many questioned the legitimacy of public health guidelines and some pointed to the shortage crisis, fearful hoarding, and purchasing of PPE as motivators for the guidance against mask use by public health officials in Canada over the initial agenda that their use could increase risks of contamination (Maher, 2020). This situation is likely exacerbated by the fact that many are desperately seeking answers to find the best means of survival during a health crisis.

Novelty of the COVID-19 Virus

Another factor that likely added to the mask debate concerns the initial lack of understanding of the virus and its mode of transmission (i.e., surface vs. airborne vs. droplet). Subsequently, this limited knowledge influenced how people perceived the role and efficacy of face masks in reducing said transmission. During this time (early January to March 2020), the state of peer-reviewed empirical research on the efficacy of face masks was limited in supporting or discrediting its risks (i.e., self-contamination from improper use) and benefits (i.e., some protection from face covering). While public health officials experienced difficulty determining the best plan of action in this ambiguous situation, many Canadians found themselves grappling with their decision to wear a face mask and had to balance the potential harm, benefits, and the discomfort that mask-wearing introduced in making their choice.

Mask-Wearing as a Cultural Issue

While the practice of mask-wearing has only recently become normalized in North America and other western countries, mask use has been commonly observed in the East, typically among East Asian countries such as Japan, China, Korea, and more (Rab et al., 2020; Howard, 2021; Zhang et al., 2022). These countries have previously used masks as a preventive

measure during previous epidemics (e.g., SARS, H1N1, MERS) and further continued to wear a mask outside of these health crises due to air pollution. Other findings suggest that anti-masking attitudes can be understood based on existing cultural frameworks such as the individualism-collectivism and independent and interdependent self-construal. For instance, Kemmelmeier and Jami (2021) found that independent self-construals were linked with unfavourable perceptions of mask-wearing while collectivism and interdependence predicted favourable perceptions of masks.

Aside from the health benefits of mask-wearing, masking has also influenced social etiquette; it is considered respectful for one to wear a mask when they speak to others. Furthermore, masking has also influenced the fashion industry in these countries. With the vast history and culture associated with masking for East Asian persons, it is possible for individuals in North America to feel a sense of culture clash donning a mask. Notwithstanding, Canadians might also adopt the pro-social attributes of mask wearing present in East Asian culture. For instance, some Canadians have perceived mask-wearing to be a symbol of social responsibility and altruisms since wearing a mask is meant to provide more protection for others as opposed to the wearer.

Mask-Wearing as a Civil Rights Issue

Some Canadians have come to perceive mask-wearing as an infringement of one's liberty. These values are highly prioritized in the doctrines of Conservatism and Republicanism. When mask mandates were instituted, there was resistance from anti-masking and anti-lockdown groups protesting mask mandates on the grounds that they violated personal rights and freedoms. As a traditionally egalitarian, individualistic, and democratic country, it is no surprise that many

experienced tensions in maintaining their sense of personal liberty while complying with government regulations.

Figure 1. Timeline of events during the first wave of the COVID-19 pandemic.

Research Objectives

Because Twitter provides a breeding ground for the emergence, development and exchange of perceptions and attitudes, it allows researchers to draw insight on public discourse during a global health crisis. We collected millions of likely-Canadian tweets using a machine learning approach from January 2020 up to September 2020 to understand the public discourse on face masks and psychological reactions to mask-wearing during the first wave of the COVID-19 pandemic. Specifically, we were generally interested in identifying key anti-masking themes and how they might change throughout the first wave in tandem with the events that occurred around that time. More specifically, we were interested in understanding the nuances in anti-maskers' concerns and justifications for their masking sentiment and the way with which users present these concerns and justifications (e.g., communication strategies).

Methods

Data Extraction

We used an existing Twitter dataset from Chen and colleagues (Chen et al., 2020) who have been continuously collecting public tweets containing COVID-related keywords since January 21, 2020, to the present date (using Twitter's streaming Application Programming Interface). For all data, we conducted standard preprocessing (i.e., case folding, stripping punctuation, and removal of stop words, URLs, and user mentions which begin with a symbol on Twitter). Because the COVID-19 Twitter dataset is unlabelled, we filtered the data for English language tweets. We also limited the corpus of our data to a specific geographic region by training a classifier that identified and extracted likely-Canadian tweets using Canadian identifiers like users geotagged location, description etc. With this filtration, we extracted tweets from the first wave of the COVID-19 pandemic, between January 21, 2020, to September 1, 2020 (See Appendix A.). A total of 5,344,555 tweets and retweets written by 22,231 users who were classified as Canadian both by spatial label propagation and our likely-Canadian user classifier (See Appendix A.). To be clear, these tweets contain COVID-related keywords and required that we extract a subsample of tweets that contained the case insensitive token "mask" for our particular analysis.

Analytical Strategy

The analytic strategy involved the following steps. First, we looked at the data descriptively by visualizing the frequency of mask-related data in the 5,344,555 total tweets. For this process we used Kibana, a dashboard software capable of data visualization. We visualized the frequency of the case insensitive tokens "mask," followed by "non-medical," "nonmedical,"

"N95," "cloth," "surgical" to assess differences in the density of tweets by mask type. We also visualized Canadian COVID cases alongside these results to gauge any parallels in the prevalence of the mask tweets and case numbers. These visualizations provided us with a sense of the entirety of the mask debate (See Figure 2 and 3.).

Next, we ran a query to search for the case insensitive token "mask" to separate the mask-related tweets from the rest of the COVID-related tweets. We arrived at 98,474 tweets and imported these 98,474 tweets into Microsoft Excel wherein we separated tweets by the month in which they were posted and manually removed users who strayed from Canadian profiles (e.g., when users' geotagged location or bio description did not contain any Canadian indicator). We arrived at 61,300 remaining tweets and imported them into NVIVO for our thematic analysis.

Thematic Analysis

According to Lincoln and Guba (1985) credibility, transferability, dependability, confirmability, and reflexivity serve as appropriate criteria for trustworthiness in qualitative research. Credible qualitative studies have research findings that are representative of and plausible given the original data (Korstjens & Moser, 2018). To maximize the credibility of our research, the main researcher incorporated strategies of prolonged engagement with the data, persistent observation, triangulation, and member check. The researcher read the tweets imported in NVIVO over an eight-month time period to become familiar with the data, achieve a greater contextual understanding of the data, and examine each data item with equal consideration. With more familiarity of the data, the researcher identified characteristics and elements with core commonalities among tweets that were most relevant for the research question; these tweets formed the foundation for our themes. Data triangulation refers to using multiple data sources in

time, space, and person. Since we extracted all tweets related to masks and COVID-19 from January up to August 2020, the tweets we used for thematic analysis came from various times in a day and different days in the year—addressing the aspect of time in triangulation. Furthermore, the tweets we collected had spatial variety since they could be posted by individuals across the Canadian provinces. However, since we relied only on users' retweets and original tweets, we did not have access to data from users' social networks when inferring their internal states and their tweets at various times during the day. Incorporating the strategy of member check, the researcher had collaborative discussions with co-authors in a reflexive manner, aiming for richer interpretations as a group, to examine the coherence of ideas.

Transferability can be defined as the extent the research findings can be applied to other contexts or settings (Lincoln & Guba, 1985). Researchers can increase the degree of transferability of their research by providing a discussion of the research process, the demographics of participants, and the contexts participants' behaviours and experiences were elicited in. Given the nature of our data, having knowledge of participants and their context relied on what the users revealed in their tweets and therefore was not always possible. Nonetheless, we deemed tweets containing such information as richer and more meaningful and incorporated them as codes for themes more often than short tweets with limited information.

The dependability of a study's research findings concerns its ability to have conveyed messages in a way that would align with participants' evaluation of the study if they were to look through the analysis (Korstjens & Moser, 2018). Likewise, confirmability is the extent to which the research findings can be confirmed by other researchers (Korstjens & Moser, 2018). The researcher regularly maintained an audit trail to maximize dependability and confirmability of the findings wherein they took note of their experience during this process to aid final

interpretation and track any changes in their engagement with the data. To reflect the users' attitudes, opinions and experiences as faithfully as possible, we used their unrevised tweets when discussing the themes but considered the interpreters' reflexive influence and subjective understanding of the meaning behind the tweets.

Using NVIVO, we investigated the textual data from the first wave using a phenomenological approach informed by Braun and Clarke's (2019) reflexive approach to thematic analysis. This method highlights the researcher's active, thoughtful and subjective role in forming interpretations of the data. We felt that this approach would be appropriate for inferring psychological concepts, such as attitudes and beliefs, from the numerous and sometimes sparse tweets. As this approach relies on the researcher's interpretive process and engagement with this abductive process, exact replication of the identified themes by an independent researcher is not expected, and hence, quantitative analysis of inter-rater reliability to establish a high degree of concordance in classification is not necessary. Instead, we had collaborative discussions with the research team in a reflexive manner, aiming for richer interpretations and coherence of ideas. As our familiarity of the data increased, we noticed core commonalities among tweets that formed the foundation for our themes.

There are some metatheoretical assumptions, conceptualized on continua, that form the basis of reflexive thematic approach and include: essentialist versus constructionist epistemologies; experiential versus critical orientation to data; inductive versus deductive analyses, and; semantic versus latent coding of data. We elaborate on where this study lies on each continua in more detail below.

Essentialist versus Constructionist Epistemologies

The essentialist versus constructivist epistemology continuum can be conceptualized as the degree to which a researcher takes a unidirectional or bidirectional understanding of the relationship between language and communicated experience respectively. When taking an essentialist approach, the researcher would be particularly interested in the denotations of language, in this case instantiated in tweets, as representing a person's experience. Therefore, there would be no need for the researcher to delve into what they would presume to be connotations of those tweets (Widdicombe & Wooffiitt, 1995). Conversely, when taking a constructionist approach, the researcher can derive meaning from both the language and the meanings inherent in that language (Braun et al. 2016).

We took a more constructionist epistemology wherein we noted tweets containing recurring information for forming themes but also paid particular attention to tweets we perceived as meaningful. For instance, we decided that three or more tweets representing the same underlying concept could serve as the threshold for a theme. However, any consequent tweet to be categorized under the same theme would need to contribute a more nuanced understanding of that theme in order to be sampled. In this way, new tweets should make the previously coded tweets richer in coherency. As such, we did not perceive the frequency of a theme as a meaningful metric for thematic analysis. This approach was also useful given the large Twitter dataset wherein, tagging every tweet would be a time constraint and so measuring the total proportion of tweets representing each theme was not feasible.

Experiential versus Critical Orientation

Researchers taking an experiential orientation to understanding the data would view the explicitly communicated thoughts, feelings and experiences of participants as a reflection of personal states. In comparison, researchers taking a critical orientation would further consider the microsocial mechanisms and contexts that could influence and/or facilitate participants' explicitly communicated experience.

While we largely took an experiential orientation to our thematic analysis process, when possible, we also used a critical orientation approach. We believed the former approach to be appropriate for examining tweets where Canadian users' clearly express their attitudes, thoughts, feelings and experiences of face masks and views such as indicators of their internal states (Braun & Clarke, 2014). However, we incorporated a critical orientation to the data when users' expressions informed our understanding of the socio-cultural factors that could underlie the development of user's personal states. As such, in our analysis we make interpretations about both Canadian users' experience with face masks and the society in which these experiences were shaped.

Inductive versus Deductive Analyses

The inductive versus deductive analyses continuum can be conceptualized as the degree to which a researcher adopts a data- or theory-driven approach. The former would rely on the content of the data while the latter would consider a pre-specified conceptual framework when crafting codes during the thematic analysis process. We predominantly used an inductive approach to thematic analysis wherein the content in users' tweets were mainly emphasized in creating core concepts. Yet, we considered the several controversial issues around the use of face

masks during the COVID-19-pandemic to inform our understanding of which tweets about face masks would be most conducive to addressing anti-masking sentiment.

Latent versus Semantic Coding of Data

In semantic coding of the data, the researcher would examine what is communicated at face-value in the data. On the other hand, researchers adhering to latent coding of data would examine the meaning of the data beyond what a participant has said or written and consider the implicit meanings, assumptions, or ideas that could have contributed to the data. We used both semantic and latent coding of the data. We appreciated and derived knowledge from tweets at face-value but often went beyond this level. Since our research concerned deeper psychological perceptions and attitudes, we actively attempted to draw underlying ideas in the Twitter data. The researcher was given the flexibility to be creative in their research role when interpreting codes and themes relevant to anti-masking sentiment. We did not prioritize semantic coding over latent coding or vice-versa.

We coded items of data that we perceived as useful for conceptualizing themes of anti-masking sentiment on Twitter. While we coded many tweets under each theme, we chose tweets as extracts for the analytical report when the tweet that best exemplified the arguments we were posing through a respective theme. We used as many extracts as we possibly needed when depicting the content, complexity, and diversity of a respective theme and the coherence among its constituents.

Results and Discussion

Visualizations and Query Searches

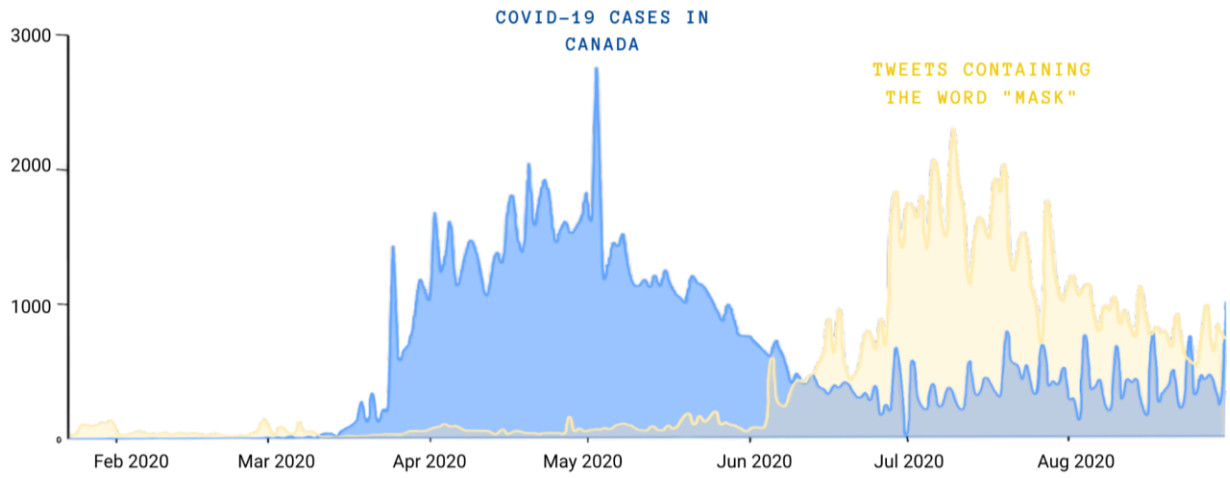

Fig 2. The frequency of tweets containing the case insensitive token “mask” superimposed over the frequency of daily COVID-19 cases in Canada across eight months from January 2020 up to September 2020.

Looking at Figure 2, we see the distributions of daily mask-related tweets in yellow superimposed onto the frequency of daily COVID-19 cases in Canada in blue. Some noteworthy dates to consider when examining this figure include the shifts in public health messaging which occurred in early April and the rise of COVID-19 cases, mask mandates and stay at home orders around May. It is likely that internet discussions about these events precipitated shortly after their occurrence such that much of the conversation around face masks and mask wearing on Twitter occurred near the end of the first wave. The time lag between rise of cases and mask discussions can also be interpreted based on the number of days it may take for people to develop COVID-19 symptoms (i.e., 12 days after exposure) wherein information seeking activity on Twitter or sharing opinions would occur after that time (Tavernise, 2020).

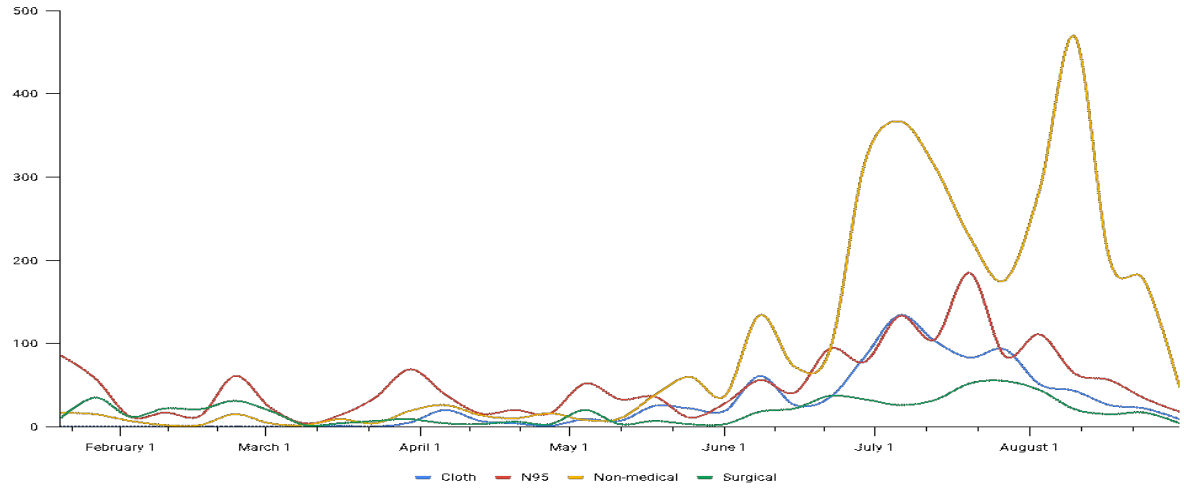

Fig 3. The frequency of daily mask-related tweets separated by mask type (e.g N95, surgical masks, cloth masks, and non-medical masks) across eight months from January 2020 up to September 2020.

Looking at Figure 3, we see the distributions of daily mask-related tweets with various lines representing different types of masks (e.g. N95, surgical, cloth masks, non-medical masks). Prior to May 2020, we see an initial pattern where N95s and surgical masks dominate much of the conversation. This pattern changes after May 2020, when we see a rise in the frequency of non-medical and cloth masks, suggesting a shift in the discourse around face masks and mask wearing. This change in discourse likely signals the onset of recommendations for cloth and non-medical masks for public use while reserving N95s and surgical masks for healthcare workers.

Thematic analysis

While analyzing the textual data, we determined that six distinct themes contributed to Canadians' anti-masking attitudes and perceptions. These themes included (1) science-based arguments; (2) perceived risk of COVID-19 and mask use; (3) negative appraisals of public

health authorities and mask guidelines; (4) infringement of civil rights; and (5) perceived conspiracies of institutional control (See Table 1.). We use the term "sentiment" to refer to users' attitudes, emotions, and opinions towards face masks during the pandemic. We labelled tweets that displayed a negative appraisal of masks or negative appraisal of things they linked to masks as anti-masking sentiment. To clarify, we obtained our findings of anti-masking sentiment as a result of thematic analysis and therefore, our use of the term "sentiment" does not imply the use of sentiment analysis (a computer science technique). When presenting the embedded tweets, we bolded the parts of the tweet we want our readers to pay particular attention to as they are following along with what is stated in the discussion and interpretation of the respective tweet.

Science-based Arguments

We coded tweets under the "science-based arguments" theme when we noticed elements of scientific argumentation, such as using research evidence and reasoning, referring to statements by scientists or medical professionals, and addressing competing scientific claims. For example, one person tweeted:

> "I have **spoken to a number of healthcare professionals,** all vastly experienced, and they all agree that wearing a mask to protect yourself from the #CoronaVirus is a complete waste of time. **Regular handwashing, avoiding touching your nose/mouth and avoiding sniffers will do**" (February, 2020)

In this tweet, the user makes a science-based argument by declaring that they have knowledgeable insight as a result of consultation with experienced experts. They perceived these individuals as a credible source of scientific information. They reasoned that the conclusions of these experts all converge on the same idea: that masks are ineffective in providing protection to a mask wearer. It is worth noting that we deemed many of the anti-masking tweets coded under the science-based arguments theme to have regard for the health and safety of the mask-wearer.

This position is exemplified by the way the user goes beyond simply disputing mask use to providing a recommendation, remedy, or solution to replace the practice of masking. They perceived these actions to be more effective and implicitly make the claim that masks are not necessary over other well-known and researched preventive health measures.

While some discussed experts' masking recommendations, others referenced the efficacy of face masks in acting as a preventive measure against COVID-19 by highlighting the type of mask and why they believe it will be ineffective in preventing transmission.

> "for those who keep **attacking** me about N95 masks. Please understand **what an N95 mask means**. An N95 is designed to block 95% of particles larger than 0.3 microns. Most **viruses** are smaller than 0.3 microns...as an **example** SARS was 0.1 microns the mask is not designed to stop it. The human Coronavirus is 0.1 - 0.2 microns. An N95 mask is **like a sieve** where the virus is smaller than the holes. The virus will be slowed down but not stopped by the filter." (March, 2020)

In the tweet, the user utilized logical reasoning supported by research evidence to bolster their stance and compel their audience, including those with opposing views, to accept their claims. We noticed that the user begins their argument by first highlighting the limitation in the N95 mask design in filtering microscopic particles like viruses. This explanation is supplemented with two examples to persuade an audience about the efficacy of masks. The first is about a previous coronavirus, SARS, that was at that time better understood than COVID-19. Identifying the roots and sources of a new problem (i.e., COVID-19) using historical examples can assist someone in their attempt to persuade their audience as this technique points to real-life, past examples as evidence (O'Neil & Hiestand, 2017). They mention that masks were not designed to "stop" SARS, a virus that the world has already dealt with. For the second example, this user provides the analogy of a sieve to display how masks are ineffective based on their design. This example is different from the first in the way it is more figurative, visual, and abstract in nature which serves as another avenue of communicating their knowledge effectively to their audience.

Although we used this tweet to discuss the science-based arguments theme, we also noticed an element of tension between two opposing sides (pro- and anti-maskers) in this tweet, a finding that has been reported in the media and the research of polarization of face masks. The user addresses a group of persons whom they assume hold opposing views regarding N95 masks and mention that these individuals are "attacking" them on the issue of N95s. They then counterattack by casting doubt on this group's understanding of face masks. Using this argumentative language is an indicator of the rising tensions around the mask debate.

Some users believed masks were not able to block all particles of the virus and therefore perceived masks as being ineffective. For instance, one user tweeted:

> "People wearing #masks and shaming others for NOT wearing them though all #science deems them almost **totally ineffective** in protecting against the nano particles of the coronavirus. #DumbPandemicDecisions #Masks4All **#MasksOff"** (April, 2020)

In this manner, masks are labelled as "totally ineffective" given that users did not deem them as an all-encompassing tool to be used. What is missing from this reasoning is the idea of combining prevention strategies to have a menu of tools against COVID-19 in reducing the risks.

The pandemic has provided an important opportunity for people to apply research findings to real-world problems. However, we believe that science-based arguments are not necessarily scientific. An individual may reason using information from scientists, medical professionals, research articles and other sources of scientific evidence, but we believe arguments to be scientific only when the individual making a claim has employed the scientific method. The scientific method is the process by which individuals systematically, critically and objectively evaluate the breadth of evidence for a claim (Voit, 2019). Given the newer scientific literature supporting the use of masks (regardless of mask type) in preventing the spread of COVID-19 that emerged around April (Fisman et al., 2020; Greenhalgh et al., 2020; Howard et

al., 2021; Ma et al., 2020; MacIntyre & Chughtai 2020; Ngonghala et al., 2020; Wang et al., 2020), many of these science-based arguments that dispute the use of masks following the changes in recommendations are not scientific, as the proposed claims are often incomplete in their analysis and seek to persuade an audience against masks. These users are likely subject to confirmation bias—the tendency to disproportionately listen to, express, and recall information based on one's existing beliefs.

Given the accessibility of social media, users can rapidly spread health and science information to a large audience (Kouzy et al., 2020; Merchant & Asch, 2018; Sharma et al., 2017) and as seen in the example tweets above, some users were able to clearly and effectively communicate their science-based reasons against mask wearing. Critically, the spread of science-based arguments that are misinformed can lead to dangerous health consequences, some which have already been noted during the pandemic like the misuse of hydroxychloroquine, bleach and other disinfecting products to treat COVID-19 symptoms (Gharpure et al., 2020). These health implications are an example of why the issue of using flawed science calls for caution. Furthermore, users may develop a sense of confidence in their perceived sound reasoning and insulate themselves from new and emerging research evidence. The following tweets are from August 2020 which is after the scientific and public health fields made revisions to mask-wearing guidelines to support their use.

> "@TTCsue @TTChelps @TTCnotices Yeah, I've never warn a mask and I won't. **I'm very well informed on the entire subject of Covid.** I know it's not necessary for masks to be mandated and that **cloth masks don't work** . U are mandating something that **does nothing** for anyone. **Educate yourself**, TTC." (August, 2020)

> "@JohnnyMacAttack Now you are going for the ridiculous, so we are done. I am too busy to have this type of debate. I have **provided you with all the information** I care to, and **I will not wear a mask. Period. End of story."** (August, 2020)

These users perceive their stance as more informed on masking and COVID-19 and therefore superior, which leads them to "end [the] story" and resist to consider the research evidence coming from ideologically opposite others. Yet, the idea that masks would not provide any benefits when used in the community is an outdated claim which evolved in light of new research findings. Furthermore, the frustration and feelings of superiority these users express towards the opposite side can also create barriers in evolving users' perception of what is scientifically true regarding mask effectiveness.

Perceived Minimal Effectiveness and Possible Harm Posed to Health by Mask Use

We coded tweets under the "perceived health risks of COVID-19 and mask use" theme when we noticed one or both of two types of health-related concerns. The first set included beliefs that COVID-19 poses a small risk to the health of the population and thus does not warrant widespread masking or mask mandates. The second set of tweets we labelled under this theme reflect the belief that mask wearing poses a risk to the health of mask wearers, and thus should not be practiced by community members. An example of the first set of tweets states:

> "Why r u living in **fear of a flu that kills 2.9%**? U do realize u have a **97.1% chance of surviving** this, right? Ur chances of **dying from obesity are greater**. I don't see a **healthy lifestyle** pandemic! But I do see every fatty in Walmart wearing a mask, buying junk food!" (March, 2020)

This tweet downplays the health risks of COVID-19 by making a comparison between COVID-19 and the flu, and then refers to a different public health crisis which is deemed as more worthy of concern than the pandemic**.** By suggesting that others are afraid of COVID-19, they suggest that they over-reacting to the risks of COVID-19, since it's "just a flu" and is unlikely to cause much harm. They also include the statistical probabilities that represent the death rate and recovery rate to make their argument seem objective, factual, and authoritative to an audience.

This user casts negative sentiment towards masks when they discuss what they perceive as unhealthy living during the pandemic. They comment about seeing "every fatty" wearing a mask, a term for describing overweight persons that has a negative connotation, therefore extending the negative sentiment onto the mask as well. For the user, those wearing masks are misguided in their concern about their health, which likely contributes to why they mention "[seeing]... [an unhealthy] lifestyle [in the] pandemic."

An example of the second set of beliefs concerning the possibility that masks might actually cause harm is illustrated in the following tweets posted by different users in March and May 2020:

> "I won't be wearing a mask. Here's why: 1. I could not keep up the change-out/sterilization protocol and would be a **danger to everyone, including myself**. 2. Social distancing is better. 3. We will have other **health problems** down the road if we all wear masks all the time." (March, 2020)
> "@sunlorrie Also: It's known the N95 mask can **cause significant hypoxia and hypercapnia. Another study** found significant reductions in blood oxygen as well. The longer the duration of wearing the mask, the greater the fall in blood oxygen levels. Study: Bader A et al. https://t.co/TmTmPmdNtg" (May, 2020)

In the first tweet, the user perceives masks to pose health risks since they feel they cannot appropriately use and dispose of their mask, and as a result, they could self-contaminate themselves. This user also believes prolonged mask use contributes to long term health consequences. Likewise, the user in the second tweet perceives masks to pose a health risk because they believe masks interfere with and cause significant breathing conditions. This user bolsters their argument with links to the research articles where they obtained their information, thereby drawing on science-based rationale to further support their stance.

Noteworthy is the mention of the possible threats posed to others' health and safety in the first tweet. We know that masks, especially non-medical masks, are mainly used to prevent the

spread of particles to those around the mask-wearer. Based on this rationale, the greatest protection is offered to others and not the person wearing the mask. This tweet was posted in March 2020, when the understanding around the use and efficacy of face masks was limited for community use. During this time, and as seen in the example tweet, some believed that the risks of mask-wearing outweighed the benefits for individuals who do not work in the health sector and have the necessary training for donning a mask. As such, the notion that masks can be harmful due to self-contamination is one that resonates closely with the earlier recommendations made against mask-wearing by public health officials in Canada. Consequently, we see how the narrative of masks as harmful for the mask-wearer may have emerged. Although we see how this issue evolves (in the following example tweets), some users still expressed these outdated views following the changes (circa April 2020) in public health recommendations of mask-wearing. The following tweet is from June 2020 and depicts this adherence to older, outdated cautions:

> "**Competent doctors** were saying this from the **beginning**. My Common Sense told me that my **mask could get contaminated and my oxygen level can drop**. I will be breathing in the air back which I just breathe out. My nose has hair which act as the filter & mask. How stupid of Canadians to follow the Media & the Govt. https://t.co/alz8HBNDuG" (April, 2020)

The inconsistent scientific communications have likely contributed to users' anchoring bias—the tendency to heavily rely on initial reports—or confirmation bias—the tendency to cherry-pick the information we recall so as to confirm our currently held beliefs.

While some perceive masks to pose a health risk because of the build-up of germs (contamination) or interfering with breathing, other individuals believed masks were harmful because they inhibited natural immunity against COVID-19 and thus contributed to the development of a compromised immune system.

> "I lived my life as if there was/is no COVID. I am not **compromising my immune system** for a virus that has a 98+% recovery rate by wearing a mask that will prevent my immune system from building up **resistance** against things we come in contact with everyday." (April, 2020)

Such users often claimed that their immune system needs COVID-19 and that the process of getting exposed to viruses, developing sickness, and recovering are all a part of developing a natural immunity. Above all, they believe that the health benefits gained by building immunity outweighs the health risks posed by COVID-19.

> "@sunlorrie Also: It's known the N95 mask can **cause significant hypoxia and hypercapnia. Another study** found significant reductions in blood oxygen as well. The longer the duration of wearing the mask, the greater the fall in blood oxygen levels. Study: Bader A et al. https://t.co/TmTmPmdNtg" (May, 2020)

Proponents of natural immunity would sometimes elaborate on aspects of healthy living that would suffice in reducing severe outcomes of COVID-19. These users often do not seem to be against or resist COVID-19 infection among young, otherwise healthy people.

> "Maybe if you are a **reasonably healthy person,** just by **going out and about everyday** keeping your self strong with exercise, sunshine and fresh air without a wearing an oxygen inhibiting face mask **your body will build up an immunity to this covid flu**. Weak and the very old beware." (June, 2020)

In this tweet, we see that this user believes those who have the ability (determined by being "reasonably healthy") to build up their immunity against COVID-19 should do so by continuing to live normally and being active. A lack of inclusivity, however, is inherent in this logic and has also been explicitly highlighted by the user when they caution a vulnerable population, older persons, to "beware."

Having a perception of COVID-19 as a low-risk disease can be harmful for several reasons that can be seen at the micro- and macro-social level. For instance, an individual who does not believe COVID-19 can significantly harm them, may get infected and pass on the virus to more vulnerable persons (e.g., immunocompromised, older persons, etc.,). Furthermore, an

accumulation of infections could overwhelm the healthcare system which would create pressure on our society as a whole. It is important for individuals who believe COVID-19 to pose minimal risk to understand that while the recovery rate is high, our society could struggle as a whole if the health care system becomes overwhelmed. From this point of view, they may begin to see the role they play in navigating the outcomes of the pandemic.

Negative Appraisals of Public Health Authorities and Mask Guidelines

We coded several tweets under the label "negative appraisals of public health authorities and mask guidelines" theme; many of these related to public health authorities and guidelines. For example, one user tweeted:

> "Now Tam & experts jump on the **wear a mask bandwagon** as the **virus wanes** & after months of saying masks **don't work or increase the risk?** Are they trying to boost China mask sales? Enough of this stupidity from the **so called 'experts'.** Canada is a waste. #cdnpoli #abpoli #ableg https://t.co/GruRuAlnZ8" (June, 2020)

In this tweet, the user first describes the new public health recommendations of mask wearing advice as "mask [band wagoning]." This word is used to make a reference to places across the country and globe that were beginning to recommend or mandate masks and suggests that these places are influencing the recommendations in Canada which downplays the legitimacy of these recommendations as being based on scientific evidence. This user implies masks are simply a fad or new trend that may not be rooted in sound reasoning. We speculate that had this individual been an advocate for mask use, they would have displayed enthusiasm in light of Canada's new mask recommendations. Moreover, this post was made in June 2020, at a time when the COVID-19 cases in Canada were declining. As such this user also believes these new mask recommendations are untimely, which likely contributes to their impression that these guidelines are not necessary. This user not only ridicules the new mask recommendations, but they also

reveal these shifts in guidelines in light of the previous public health messages (that masks do not work or can increase the risk of infection) to globally cast negative appraisal towards Canadian experts. They conclude by mentioning how these changes and new recommendations are foolish. These impressions of Canadian public health officials can make them appear as lacking in credibility and competence, which can elicit a sense of skepticism and distrust towards public health recommendations for people in light of the inconsistencies in public health messaging and information crisis.

From our analysis, we also discovered that the perceived credibility of public health officials seems to be closely related to how trustworthy they appear.

> "This dishonest, unprofessional crap better NOT be happening in Alberta. When we **can't trust** the Information coming from public health officials there is no need for said officials. You should be fired & you can take your **mask wearing legislation** & stick it. @TOPublicHealth https://t.co/PdSbHaRaro" (May, 2020)

In the abovementioned tweet, the user declares a collective lack of trust in public health officials which seems to have been influenced by shifts in public health messages as these changes may have been perceived as "dishonest" and "unprofessional." Subsequently, they make a causal claim that public health officials in Canada are not needed given that they have damaged the public's trust. It appears that the user extends the negative sentiment towards these officials to the public health mask mandates they were endorsing. This tweet clearly displays the kind of consequences (in resistance to masks and mask mandates) that can arise as a result of ineffective communication, and when the public's trust in authorities is weakened. These possibly exacerbated some people's suspicions and contributed to the anti-masking mandates and lockdown protests that emerged.

While it is true that the public health messaging around face masks might not have been clear and consistent, we can still acknowledge that scientific consensus evolves with new information. This notion is especially relevant in the case of a novel disease where uncertainties about the virus are numerous. Given that uncertainty, it is understandable that officials changed their recommendations but it is also understandable that people would have doubts given these shifts. From the people's perspective, these shifts can signal a lack of assurances in the legitimacy of the future health directives because they may wonder what could stop officials from changing their stance again?

> "@roccogalatilaw They can't even come up with a test that is reliable never mind a vaccine. The same people who said
> - don't close the borders/yes close the borders
> - don't wear a mask/yes wear a mask
> will **now tell you the vaccine** they inject you with is **SAFE**." (July, 2020)

In the above-mentioned tweet, the perceived shifts in public health messaging are used as evidence against a future health directive, vaccinations, to suggest that the health officials could later reveal that the vaccines they administered were not safe. This tweet provides insight into the need for exercising caution in the early stages of a health crisis given people may scrutinize health authorities' initial handling of the crisis as indicative of how the future could play out.

Infringement of Civil Rights

We coded tweets under the "infringement of civil rights" theme when users shared beliefs that mask wearing should be a choice, and restrictions and mandates implemented to enforce this behaviour impacted a person's freedom. For instance, one user tweeted:

> "if you want to wear a mask **wear one** if it makes you feel good if you don't want to wear one **don't wear one** if you're **afraid** to go out that your business.(If I don't want to wear a mask that's my business). [But it's the **right** of the people to **choose** not the government." (March, 2020)

This tweet shows the user's belief that having the choice to decide to wear or not to wear a mask should be equally respected. However, this user makes a distinction between what a mask does and means for another person who chooses to wear a mask. For this individual, others wear a mask because it might provide them with psychological security to make an individual "happy." This perception of masks downplays the legitimacy of masks in preventing the spread of COVID-19 while simultaneously suggesting that making masks mandatory would be an overreach of government power. This post was made in March, prior to when mask mandates were instituted.

In the next tweet, we see another user express their views by making a comparison between Sweden and their own country in how COVID-19 was handled. During this time, Sweden stood in contrast to all other countries that had implemented lockdowns, work from home orders, and mask wearing.

> "**Math** is only hard when you don't like the answer...**Sweden** showed that #COVID19 can be **defeated** without **lockdowns**, without **mask mandates,** without destroying the **economy**, without closing the schools and without **violating human rights**" (June 2020)

This individual discusses how Sweden has experienced no problems with COVID-19 infections or death with their lack of restrictions. In this manner they praise Sweden for having preserved human rights. This user is pointing attention to these facts for the sake of disputing the need for masks and other restrictions which they believe have placed pressure on the global economy. Interestingly however, Yarmol-Matusiak and colleagues (2021) discovered a rise in the mortality rate in Sweden with a rise in the mortality rate compared to Norway between March and June 2020, specifically among older persons. Sweden began to finally recommend masks in December 2020. The authors state that the absence of masking guidelines likely contributed to the arguably

adverse outcomes in Sweden which provides insight on the accuracy of this user's claim that Sweden "defeated" COVID-19.

We also discovered that many tweets that we coded under this theme included the notion that compromising one's rights to wear a mask is a gateway to future compromises. For instance, the following user discusses the need for anti-maskers to gather, protest, and resist mask wearing in order to build up their defences when vaccines become mandatory.

> "Thanks buddy UNITED WE STAND DIVIDED WE FALL so far we ARE ALL DIVIDED **the only time we can win** is when WE ARE ALL **UNITED** TOGETHER NO MATTER THE RACE, COLOR OR CREED we must stand TOGETHER FOR OUR RIGHTS to CHOOSE not to wear a FACE MASK and **refuse the coming VACCINE** https://t.co/88aT8SWcFJ" (August, 2020)

For this user, public health officials and other government authorities are perceived to be using a foot in the door technique. By accepting one request that is less invasive (mask wearing regulations), this technique would suggest that people would become more likely to accept another request that is more invasive (vaccinations). This user perceives wearing a mask signals a slippery slope that will lead to more mandates. As such many anti-maskers may feel that they need to resist mask wearing as a way of preventing future regulations.

Perceived Conspiracies of Institutional Control

We coded facemask tweets under the "perceived conspiracies of institutional control" theme when users expressed concerns about COVID-19-related conspiracies. These beliefs often portrayed users' perceived impression of a higher-order organization or institution as being in control and having intention of manipulating the masses in a manner unbeknownst to them. For instance one user tweeted:

> "If you are making excuses to justify wearing a mask, you won't have the backbone or the will to resist what's coming next… Just as I have been saying...

> [**They**] won't stop until vaccines are mandatory. The vaccine is **their** end game. https://t.co/Xxe4wfEn4z" (July, 2020)

We discovered that naming the exact nature of who users are referring to was challenging since many users will refer to this omnipresent body ambiguously, lacking in content and explanation.

> "when people are so sick of wearing masks..so sick of the social distancing rules, they will gladly accept **their vaccine** to be released of the mask. That will become **their ultimatum.** I'm not living like this is the new normal like a **good little lamb** ! I'm never getting vaccinated" (April, 2020)

> "If a business requires a mask, I will not shop there. If a restaurant requires a mask, I will not eat there. If an event requires a mask, I will not attend. I will not participate in this act of **societal behavior control**. #NoMasks #COVID19 #MyBodyMyChoice #UNmask Do NOT become their slave." (July, 2020)

Based on our readings of the tweets as well as the ones mentioned above, we believe that individuals could be referring to government institutions, political figures, pharmaceutical companies, and/or the media when discussing "they." In this theme, masks are often perceived negatively because these individuals perceive it as a tool for large-scale population control.

These tweets often portrayed the pandemic, masks, and masking mandates as devices that these institutions use to manipulate an unwitting and conformist public.

> "@JJCrosstrainers Agreed, but there are so many **SHEEPLE** that just go along with it. It's just a lock down. It's only 2 flatten curve. **It's just a mask**. It's just an app to track you. It's just googles. It's just a micro chip. It's just a vaccine. YOU NEED ALL OF THIS TO GET **YOUR LICENCE PLATES.**" (March, 2020)

> "The mask, the social distancing, the lockdown, the news cycle...part of the intended purpose is to **wear you down mentally** and get you to accept their hasty solution to the virus. https://t.co/nPB4IGrP6W" (August, 2020)

By expressing that there are many "SHEEPLE," this user creates a distinction between themselves, as someone who is informed of "their" ulterior motives, and others, who are mindlessly allowing themselves to be controlled by "them". After listing the already existing restrictions and mandates, this user attempts to reveal what they believe to be the hidden agenda, such as human tracking and vaccinations. The second tweet also does this by revealing that the

purpose behind all these restrictions and guidelines is to produce psychological fatigue so as to make the option of taking a vaccine (when made available) appear attractive. They conclude these institutions of authority will ultimately implement rules that will the population to play into their interests (i.e.,"YOU NEED ALL OF THIS TO GET YOUR LICENCE PLATES"). The user is making the claim that masks and mask mandates are a part of an immoral agenda being imposed by the government to control people's behaviour and personal development. This tweet reflects the strong ideas and sentiments that exist among anti-maskers who partake in conspiracies and perceive the pandemic and mask-wearing as a facade.

In the extreme case, some of these individuals will go as far as saying that the COVID-19 virus was human-engineered, and that these institutions are spreading lies about COVID-19 and masks as a means to control people.

> "600,000 people were told they had COVID-19 despite not being tested **No! There is no manipulation here**... now **run along** wear your mask and do as your told. #**lies** #manipulation #covid #nomask #nofear #canada #usa #bullshit #novaccine https://t.co/28ehGtazP9" (August, 2020)

As seen in the abovementioned tweet, some users entertained bizarre notions of mind control and conspiracies about government manipulation. Some others discussed the recovery rate, false reporting about cases and suggested that these stats are being inflated and framed by the media in a way to scaremonger citizens into compliance. These claims can be attractive because they might provide an illusion of causality and subject us to the general causality bias—the tendency to perceive a causal relationship when none exists (Matute et al., 2011).

Anti-masking as a Multifaceted Rationale

After revision of our themes, we arrived at the finding that anti-masking sentiment is likely a multifaceted rationale such that these aforementioned factors concurrently bolstered each

other as well as other potential factors that did not emerge from our thematic analysis (See Table 2.). Because many of the tweets encapsulated a tangle of rationales where more than one of these distinct but related concepts were discussed simultaneously and in relation to each other.

> "@superhongkongh1 @NiceGoingAdam @Alyssa_Milano Corona will get passed a face cloth covering **That's a FACT** But..If you want to wear a symbol to make yourself 'feel' like you are protecting ANYONE or yourself help yourself to mask happiness **You are free** to do as you wish, just like the rest of us." (February, 2020)

In the above-mentioned tweet, an individual touches on both face mask efficacy as well as infringement of civil rights.

> "They **keep moving the goalposts.** What started out as "15 days to slow the spread and flattening the curve to save the hospitals..." Has now turned into... "Please stay at home until further notice, we've **canceled your constitution**. Put on your mask and wait for the vaccine." (May, 2020)

In the above-mentioned tweet, an individual touches on both negative appraisals of public health authorities and mask guidelines as well as infringement of civil rights.

> "The #COVID agenda is about **downsizing**, By using COVID to hammer the economy, they tell us to make do with **less freedom,** less wealth, **less access to the good life.** By forcing us to mask up, they tell us **not to be greedy for 02**, to get along with smaller amounts of the breath of life https://t.co/ZCgCc7EHcR" (July, 2020)

In the above-mentioned tweet, an individual touches on perceived conspiracies of institutional control, infringement of civil rights, and perceived health risks of COVID-19 and mask use.

These tweets show us that people often think and talk about many of our themes concurrently. As seen in Table 2, much of the polysemic tweets began to emerge around May 2020, whereas a review of Table 1, shows that tweets with a discussion of only one theme can be noted as early as January and February. Given that these themes evolved to occur more concurrently, we speculate that there was an incubation period where anti-maskers expressed their varied views which later evolved to contain more than just one theme as a result of social

influence from other views shared by anti-maskers. Given the desire for conformity and the need for validation in an uncertain time, these processes could have led to dysfunctional judgments (e.g., COVID-19 conspiracies).

Conclusion

From our analysis of anti-masking sentiment tweets, we see that people perceive the act of mask-wearing as more than just a practical preventive health strategy, but also as an action that can represent personal beliefs. Based on our findings, we maintain that Twitter users consider the symbolic nature of mask-wearing, such as the cultural messages associated with donning a mask and the psychological, social, and economic impact of mask-wearing (Grundmann et al., 2021; Rieger, 2020; Scheid et al., 2020). While many made science-based arguments to rationalize their masking stance, the symbolic nature of masks for the mask wearer takes the mask debate beyond a matter of science and introduces an aspect of an individual's social identity—one that can be challenged or reinforced based on their behaviours and attitudes.

Aligning with Merkley and Loewen's (2021) research findings, we found that people expressed skepticism of government official's mask wearing recommendations. However, we focused this paper on anti-masking attitudes, and in other preliminary analyses using the same data, we have also seen that some users attempted to bridge the inconsistencies in messaging from public health officials. Thus, reporting that we found a sense of distrust of experts should not be considered as representative of all appraisals that have been proposed regarding public health officials on Twitter. Similar to Rieger's findings (2020), we also found that users' worries about the COVID-19 situation, whether masks offered self-protection or protection for others, as well as thinking that wearing a mask looks strange were mentioned in the tweets we reviewed.

Drawing from Self-Determination Theory, Schied and colleagues (2020) mention that autonomy constitutes one of the universal and fundamental needs for wellbeing. Considering this, wearing a mask can be an instance where an individual may feel that their autonomy— having free will and choice over one's actions—has been compromised, thus, people might experience psychological reactance, and resist mask wearing, as a way to restore that freedom. Although we are not able to draw causal conclusions from our interpretations of users' tweets, psychological reactance might be able to provide understanding of our "infringement of civil liberties" theme.

Limitations and Directions for Future Studies

The present study provides several new insights into anti-masking sentiments during the first wave of COVID, but there are nonetheless several limitations that require additional study. First, we analyzed the tweets using a regional context and filtered our dataset geographically using a Canadian classifier. However, a limitation to this strategy is that users who share their device location represent less than 1% of the Twitter population (Sloan et al., 2013). Moreover, some studies have reported that 34% of user-specified profile locations are unusable, and that the remainder of the users may not reliably represent tweet origin (Sloan et al., 2013). Other computer science techniques that provide greater accuracy in limiting tweets to a geographic region could be used in future studies.

Second, while we examined an extended period in our research as opposed to other studies that focused on shorter time periods, we believe that a more robust approach to longitudinal research during the first wave and extending beyond this time point would be valuable. Longitudinal research of the COVID-19 pandemic in the recent waves could inform public officials' strategies of transitioning out of the pandemic. For instance, this research could

provide insight of new concerns of masking and the groups of people that are expressing these concerns which are important for creating effective interventions. We also believe that researchers who aim to understand attitudes and psychological responses should choose their method of analysis in a way that can be insightful from a social science perspective. This approach is critical given that there can be limitations in inferring personal states with some computer science techniques. For instance, topic modelling is a computer science technique that is well suited for determining prevalent topics in a large corpus of data. However, simply knowing what is being discussed is not equivalent to knowing how the topic is being discussed, both of which can be informative depending on the scientist's research question.

Third, this Twitter-based study did not differentiate subpopulations within Canadian society. For instance, previous studies found that COVID-19 mask rhetoric in social media is gendered, and that there is a gender difference in the likelihood of mask-wearing in public. There is also evidence that political orientation influences perceptions of mask-wearing. We did not examine the gender identification of the tweeters in this study, and the extent to which the stances in our data are divided along gender lines awaits future investigation.

Fourth, Twitter is good for understanding masking attitudes due to its open interface that provides researchers access to large amounts of organic statements. In this big corpus of data, numerous unique views can be discovered, which can allow us to better grasp diverse perspectives. However, some users on Twitter do not provide demographic information and so conducting research that investigates relationships between attitudes and subpopulations is limited. For instance, previous studies that use surveys have found that COVID-19 mask rhetoric is gendered, that there is a gender difference in the likelihood of mask-wearing in public. There is also evidence that political orientation influences perceptions of mask-wearing. We did not

examine the gender or political identification of the Twitter users in this study, and the extent to which the stances in our data are divided along gender or partisan lines awaits future investigation. Using Twitter to identify relationships between demographics and attuitudes may be tricky and could demand elaborate computer science skills that may be uncommon for researchers in the social sciences. Thus, reviewing researchers' previous works using Twitter data and in collaboration with an interdisciplinary team of computer science researchers experienced in this field could assist in determining possible analytical strategies. However, the findings derived from these studies should be supplemented through other research methods to support their validity.

Finally, given our in-depth analysis of tweets, future studies could utilize the tweets we coded in Tables 1 and 2 to develop a specialized machine learning classifier for a more efficient, timelier approach to identifying themes. This computer-driven approach could assist in the initial grouping of tweets, which could then be supplemented with human interpretation to bring attention to the nuances present within the groups. This dual approach, as was used in the present analysis, could possibly point to sub-themes or the emergence of new themes. Using this method would also address a limitation in our study, grasping the prevalence of themes in the context of the whole mask debate occurring on Twitter.

Implications

In the future when faced with a novel health crisis, we recommend that public health officials to remember that the absence of evidence for new health interventions does not equate evidence of absence for their efficacy. Therefore, early messaging in uncertain times should be

delivered in a manner that vocalizes to the public how initial guidelines are prone to future change given the evolving nature of the knowledge base.

We discovered that the initial public health guidelines against mask use, which were based on the assumption that the public lacked training for proper use and faced potential self-contamination, deterred some users from believing in their self-efficacy when recommendations eventually changed in favour of mask-wearing. We believe that public officials should consider putting greater faith in the public's ability to adapt and learn new behaviours. People may be in fact be quite motivated to learn the most effective mask use in order to stay alive in a deadly pandemic.

While some people can readily adapt to changes in practices, such as incorporating the routine use of masks in their lives, others may experience more difficulty in modifying long-standing habits. Based on our readings, we believe it is important for Canadian officials to publicly recognize that people can dislike masks. By acknowledging the reasons why people can perceive masks unfavourably, government officials might be able to establish a connection built on a sense of understanding for the public concern. We believe this connection is especially important given the stigma that many pro-maskers have towards anti-masking attitudes. Since stigmatization can lead to social alienation, polarized subgroups deeply against mask-wearing can emerge that make it more difficult for officials to ideologically influence. Therefore, public understanding of anti-maskers' concerns could potentially alleviate feelings of stigma for those who share this view and make them feel less socially alienated. Once this connection is established, we can address the issues that anti-maskers are experiencing, for instance, improving people's sense of individuality when wearing a mask.

Given the uncertainty of the COVID-19 virus and situation, we also found that we can be prone to cognitive biases that contribute to poor decision-making. Many of the science-based arguments were selectively chosen to align with users' beliefs. To address people's use of flawed science, we recommend that not only public health officials, but also academic and other scientific organizations share knowledge of how properly interpret the findings reported in scientific studies. This grounding is especially critical given people's ease of access to and shareability of scientific information, including faulty, incomplete and/or outdated research findings can contribute to the spread of misinformation.

According to Haidt's (2001) discussion of the social intuitionist model, people's initial judgements are influenced by their emotions and intuition, and these colour people's reasoning and decision. This model is helpful when understating the implications involved with persuading someone from an opposing party on controversial issues and the types of strategies one can use in this process. This model suggests that when it comes to mask-wearing, pro- and anti-maskers will have different reasons for their masking behaviours, but each will think their views hold higher ground than the other. Since these emotional, intuitive judgements are said to appear in consciousness automatically and effortlessly, this model suggests that strategy of trying to persuade someone reasoned arguments will not usually be effective. Instead, it is necessary to appeal to each other on an emotional level instead of a rational one. If proponents of masking can get the opposition to feel the same emotions the former is feeling, then advocates for masking might be able to trigger different intuitive judgments in critics of masking (which may then trigger different reasoning and behavioural outcomes). A re-examination of the data and the existing literature in search of finding common-ground or common-concerns between pro- and anti-maskers can assist in crafting interventions aiming to increase mask compliance.

Mining opinions based on tweets may be a timely and useful tool for obtaining an overview of the public's opinions towards mask usage during COVID-19. The information extracted through tweet analysis can be used as a complementary source for other analysis methods, such as surveys, to better shape the public's opinion on wearing masks. The approach can be useful for the public health authorities when deciding the policies to be used in emergency situations. Furthermore, we can extend the findings of our study to future research interested in examining reluctance towards health behaviours such as mask wearing and vaccination

Haidt (2020) provides other, longer-term solutions for persuading people to practice facemask use, including creating a culture that fosters balanced, reflective, and fair-minded styles of judgment through modelling and looking at problems from multiple perspectives. This broader perspective may gradually "tune up" intuitions about justice, rights, etc. We offer the following recommendations: For broad-reaching effects and stronger impact, public health recommendations should be delivered to the public via multiple channels and sources, and by reputable medical health professionals. These professionals could also play a role in influencing social media discourse. As such, it is important for them and other verified users to actively try to balance polarized views on the internet to foster a culture of open mindedness online. Public health officials could consider implementing creative, engaging health communication strategies to address misinformation on social media platforms (e.g., posting entertaining Twitter, Instagram or TikTok videos discussing face masks and their use).

Final Remarks

Despite the demonstrated effectiveness of masks in mitigating the spread of the coronavirus disease 2019 (COVID-19), mask wearing as a safety precaution was a source of

controversy in Canada during the COVID-19 pandemic. Drawing on users' Tweets during the first wave of the pandemic, this study provides a nuanced discussion of anti-masking sentiment in the social media discourse of face masks, identifying seven themes that percolated through this discourse. We discussed possible ways that government institutions and policy makers can address the issues raised in these thematic categories. This study underscores the importance of interdisciplinary research to assist policy makers, government and public health officials, clinicians, and researchers on public discourse during a health crisis. Although more extensive analyses are desirable, including longitudinal analyses across the first and subsequent waves of the COVID-19 pandemic, their findings of the present analysis nonetheless can aid in the design and implementation of research-informed public health guidelines, health messaging, and science communication tools meant to optimize adherence to preventive measures, control misinformation, and deter public confusion during early stages of health crises.

References

Adamic, L. A., & Glance, N. (2005). The political blogosphere and the 2004 U.S. election: Divided they blog. *Proceedings of the 3rd International Workshop on Link Discovery*, 36–43. https://doi.org/10.1145/1134271.1134277

Alamsyah, A., & Adityawarman, F. (2017). Hybrid sentiment and network analysis of social opinion polarization. *2017 5th International Conference on Information and Communication Technology (ICoIC7)*, 1–6. https://doi.org/10.1109/ICoICT.2017.8074650

Allcott, H., Boxell, L., Conway, J., Gentzkow, M., Thaler, M., & Yang, D. (2020). Polarization and public health: Partisan differences in social distancing during the coronavirus pandemic. *Journal of Public Economics*, *191*, 104254. https://doi.org/10.1016/j.jpubeco.2020.104254

Arguments against mask requirements during the coronavirus (COVID-19) pandemic, 2020-2021. (n.d.). Ballotpedia. Retrieved June 19, 2022, from https://ballotpedia.org/Arguments_against_mask_requirements_during_the_coronavirus_(COVID-19)_pandemic,_2020-2021

Badillo-Goicoechea, E., Chang, T.-H., Kim, E., LaRocca, S., Morris, K., Deng, X., Chiu, S., Bradford, A., Garcia, A., Kern, C., Cobb, C., Kreuter, F., & Stuart, E. A. (2021). Global trends and predictors of face mask usage during the COVID-19 pandemic. *BMC Public Health*, *21*(1), 2099. https://doi.org/10.1186/s12889-021-12175-9

Bode, L., Hanna, A., Yang, J., & Shah, D. V. (2015). Candidate Networks, Citizen Clusters, and Political Expression: Strategic Hashtag Use in the 2010 Midterms. *The ANNALS of the*

American Academy of Political and Social Science, *659*(1), 149–165. https://doi.org/10.1177/0002716214563923

Borge-Holthoefer, J., Magdy, W., Darwish, K., & Weber, I. (2015). Content and Network Dynamics Behind Egyptian Political Polarization on Twitter. *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*, 700–711. https://doi.org/10.1145/2675133.2675163

Bogart, N. (2020, July 20). March to Unmask: Rallies decrying mandatory mask policies held across Canada. CTV News. https://www.ctvnews.ca/health/coronavirus/anti-mask-rallies-held-across-canada-despite-increased-support-for-mandatory-masks-1.5031078

Bozdag, E., Gao, Q., Houben, G.-J., & Warnier, M. (2014). Does offline political segregation affect the filter bubble? An empirical analysis of information diversity for Dutch and Turkish Twitter users. *Computers in Human Behavior*, *41*, 405–415. https://doi.org/10.1016/j.chb.2014.05.028

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, *11*(4), 589–597. https://doi.org/10.1080/2159676X.2019.1628806

Braun, V., Clarke, V., & Weate, P. (2016). Using thematic analysis in sport and exercise research. In B. Smith, & A. C. Sparkes (Eds), *Routledge handbook of qualitative research in sport and exercise.* Routledge. https://doi.org/10.4324/9781315762012.ch15

Bravo, R. B., Del Valle, M. E., & Gavidia, À. R. (2015). A multilayered analysis of polarization and leaderships in the Catalan Parliamentarians' Twitter Network. *2015 Fifteenth International Conference on Advances in ICT for Emerging Regions (ICTer)*, 200–206. https://doi.org/10.1109/ICTER.2015.7377689

Chen, E., Lerman, K., & Ferrara, E. (2020). Tracking Social Media Discourse About the COVID-19 Pandemic: Development of a Public Coronavirus Twitter Data Set. *JMIR Public Health and Surveillance*, *6*(2), e19273. https://doi.org/10.2196/19273

Centers for Disease Control and Prevention (2020). COVID-19: Considerations for Wearing Masks. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cloth-face-cover-guidance.html.

Clarke, V., & Braun, V. (2016). Thematic analysis. *The Journal of Positive Psychology*, *12*(3), 1–2. https://doi.org/10.1080/17439760.2016.1262613

Conover, M. D., Ratkiewicz, J., Francisco, M., Gonçalves, B., Menczer, F., & Flammini, A. (2011). Political Polarization on Twitter. *Proceedings of the International AAAI Conference on Web and Social Media, 5*(1), 89-96. Retrieved from https://ojs.aaai.org/index.php/ICWSM/article/view/14126

Dillard, J. P., Tian, X., Cruz, S. M., Smith, R. A., & Shen, L. (2021). Persuasive Messages, Social Norms, and Reactance: A Study of Masking Behavior during a COVID-19 Campus Health Campaign. *Health Communication*, *0*(0), 1–11. https://doi.org/10.1080/10410236.2021.2007579

Finn, S., Mustafaraj, E., & Metaxas, P. T. (2022). *The Co-retweeted Network and Its Applications for Measuring the Perceived Political Polarization*. 276–284. https://www.scitepress.org/Link.aspx?doi=10.5220/0004788702760284

Fisman, D. N., Greer, A. L., & Tuite, A. R. (2020). Bidirectional impact of imperfect mask use on reproduction number of COVID-19: A next generation matrix approach. *Infectious Disease Modelling*, *5*, 405–408. https://doi.org/10.1016/j.idm.2020.06.004

Flood, C. M., MacDonnell, V., Thomas, B., & Wilson, K. (2020). Reconciling civil liberties and public health in the response to COVID-19. *FACETS*, *5*(1), 887–898. https://doi.org/10.1139/facets-2020-0070

Meta-research Innovation Center at Stanford. (2020). Formal request for the retraction of Zhang et al., 2020. Retrieved June 19, 2022, from https://metrics.stanford.edu/PNAS%20retraction%20request%20LoE%20061820

Foss, S. K., Foss, K. A., & Trapp, R. (2001). Contemporary Perspectives on Rhetoric (3rd edition). Waveland Pr Inc.

Garcia, D., Abisheva, A., Schweighofer, S., Serdült, U., & Schweitzer, F. (2015). Ideological and Temporal Components of Network Polarization in Online Political Participatory Media. *Policy & Internet*, *7*(1), 46–79. https://doi.org/10.1002/poi3.82

Garimella, K., Weber, I., & De Choudhury, M. (2016). Quote RTs on Twitter: Usage of the new feature for political discourse. *Proceedings of the 8th ACM Conference on Web Science*, 200–204. https://doi.org/10.1145/2908131.2908170

Gharpure, R. Radhika Gharpure, DVM1,2; Candis M. Hunter, PhD1; Amy H. Schnall, MPH3; Catherine E. Barrett, PhD1; Amy E. Kirby, PhD1; Jasen Kunz, MPH1; Kirsten Berling, MPH1; Jeffrey W. Mercante, PhD1; Jennifer L. Murphy, PhD1; Amanda G. Garcia-Williams, PhD1(2020). Knowledge and Practices Regarding Safe Household Cleaning and Disinfection for COVID-19 Prevention—United States, May 2020. *MMWR. Morbidity and Mortality Weekly Report*, *69*(23), 705-709. https://doi.org/10.15585/mmwr.mm6923e2

Greenhalgh, T., Schmid, M. B., Czypionka, T., Bassler, D., & Gruer, L. (2020). Face masks for the public during the covid-19 crisis. *BMJ (Clinical Research Ed.)*, *369*, m1435. https://doi.org/10.1136/bmj.m1435

Grundmann, F., Epstude, K., & Scheibe, S. (2021). Face masks reduce emotion-recognition accuracy and perceived closeness. *PLOS ONE*, *16*(4), e0249792. https://doi.org/10.1371/journal.pone.0249792

Gruzd, A., & Roy, J. (2014). Investigating Political Polarization on Twitter: A Canadian Perspective. *Policy & Internet*, *6*(1), 28–45. https://doi.org/10.1002/1944-2866.POI354

Haidt, J. (2001). The emotional dog and its rational tail: A social intuitionist approach to moral judgment. *Psychological Review, 108*, 814-834. https://doi.org/10.1037/0033-295X.108.4.814

Howard, J., Huang, A., Li, Z., Tufekci, Z., Zdimal, V., van der Westhuizen, H.-M., von Delft, A., Price, A., Fridman, L., Tang, L.-H., Tang, V., Watson, G. L., Bax, C. E., Shaikh, R., Questier, F., Hernandez, D., Chu, L. F., Ramirez, C. M., & Rimoin, A. W. (2021). An evidence review of face masks against COVID-19. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(4), e2014564118. https://doi.org/10.1073/pnas.2014564118

Howard, M. C. (2021). Gender, face mask perceptions, and face mask wearing: Are men being dangerous during the COVID-19 pandemic? *Personality and Individual Differences*, *170*, 110417. https://doi.org/10.1016/j.paid.2020.110417

Kemmelmeier, M., & Jami, W. A. (2021). Mask Wearing as Cultural Behavior: An Investigation Across 45 U.S. States During the COVID-19 Pandemic. *Frontiers in Psychology*, *12*. https://www.frontiersin.org/article/10.3389/fpsyg.2021.648692

Korstjens, I., & Moser, A. (2018). Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*, *24*(1), 120–124. https://doi.org/10.1080/13814788.2017.1375092

Kouzy, R., Jaoude, J. A., Kraitem, A., Alam, M. B. E., Karam, B., Adib, E., Zarka, J., Traboulsi, C., Akl, E. W., & Baddour, K. (2020). Coronavirus Goes Viral: Quantifying the COVID-19 Misinformation Epidemic on Twitter. *Cureus*, *12*(3). https://doi.org/10.7759/cureus.7255

Ladapo, J., A. (2020, October 28). Masks are a distraction from the pandemic reality. WSJ. https://www.wsj.com/articles/masks-are-a-distraction-from-the-pandemic-reality-11603927026

Lincoln, Y. S., & Guba, E. G. (1985). Naturalistic Inquiry. SAGE.

Ma, Q.-X., Shan, H., Zhang, H.-L., Li, G.-M., Yang, R.-M., & Chen, J.-M. (2020). Potential utilities of mask-wearing and instant hand hygiene for fighting SARS-CoV-2. *Journal of Medical Virology*, *92*(9), 1567–1571. https://doi.org/10.1002/jmv.25805

Mccanin, M. (2020, May 27). Mandatory masks aren't about safety, they're about social control. The Federalist. https://thefederalist.com/2020/05/27/mandatory-masks-arent-about-safety-theyre-about-social-control/

Maher, S. (2020, March 31). The coronavirus question: To mask or not to mask. MACLEAN'S. https://www.macleans.ca/news/canada/the-coronavirus-question-to-mask-or-not-to-mask/

Marozzo, F., & Bessi, A. (2017). Analyzing polarization of social media users and news sites during political campaigns. *Social Network Analysis and Mining*, *8*(1), 1-13. https://doi.org/10.1007/s13278-017-0479-5

Matute, H., Yarritu, I., & Vadillo, M. A. (2011). Illusions of causality at the heart of pseudoscience. *British Journal of Psychology*, *102*(3), 392–405. https://doi.org/10.1348/000712610X532210

Medaglia, R., & Zhu, D. (2016). Paradoxes of Deliberative Interactions on Government-Managed Social Media: Evidence from China. *Proceedings of the 17th International Digital Government Research Conference on Digital Government Research*, 435–444. https://doi.org/10.1145/2912160.2912184

Medaglia, R., & Zhu, D. (2017). Public deliberation on government-managed social media: A study on Weibo users in China. *Government Information Quarterly*, *34*(3), 533–544. https://doi.org/10.1016/j.giq.2017.05.003

Merchant, R. M., & Asch, D. A. (2018). Protecting the Value of Medical Science in the Age of Social Media and "Fake News." *JAMA*, *320*(23), 2415–2416. https://doi.org/10.1001/jama.2018.18416

Merkley, E., Bridgman, A., Loewen, P. J., Owen, T., Ruths, D., & Zhilin, O. (2020). A Rare Moment of Cross-Partisan Consensus: Elite and Public Response to the COVID-19 Pandemic in Canada. *Canadian Journal of Political Science/Revue Canadienne de Science Politique*, *53*(2), 311–318. https://doi.org/10.1017/S0008423920000311

Merry, M. (2016). Making friends and enemies on social media: The case of gun policy organizations. *Online Information Review*, *40*(5), 624–642. https://doi.org/10.1108/OIR-10-2015-0333

Ngonghala, C. N., Iboi, E., Eikenberry, S., Scotch, M., MacIntyre, C. R., Bonds, M. H., & Gumel, A. B. (2020). Mathematical assessment of the impact of non-pharmaceutical

interventions on curtailing the 2019 novel Coronavirus. *Mathematical Biosciences*, *325*, 108364. https://doi.org/10.1016/j.mbs.2020.108364

O'Neil, K., & Hiestand, E. (2017). 3 Questions: How history helps us solve today's issues. MIT News. https://news.mit.edu/2017/3-questions-how-history-helps-solve-todays-issues-0228

Pennycook, G., McPhetres, J., Bago, B., & Rand, D. (2020). *Beliefs about COVID-19 in Canada, the U.K., and the U.S.A.: A novel test of political polarization and motivated reasoning*. PsyArXiv. https://doi.org/10.31234/osf.io/zhjkp

Primario, S., Borrelli, D., Iandoli, L., Zollo, G., & Lipizzi, C. (2017). Measuring Polarization in Twitter Enabled in Online Political Conversation: The Case of 2016 US Presidential Election. *2017 IEEE International Conference on Information Reuse and Integration (IRI)*, 607–613. https://doi.org/10.1109/IRI.2017.73

Rab, S., Javaid, M., Haleem, A., & Vaishya, R. (2020). Face masks are new normal after COVID-19 pandemic. *Diabetes & Metabolic Syndrome*, *14*(6), 1617–1619. https://doi.org/10.1016/j.dsx.2020.08.021

Rieger, M. O. (2020). To wear or not to wear? Factors influencing wearing face masks in Germany during the COVID-19 pandemic. *Social Health and Behavior*, *3*(2), 50. https://doi.org/10.4103/SHB.SHB_23_20

Romenskyy, M., Spaiser, V., Ihle, T., & Lobaskin, V. (n.d.). Polarized Ukraine 2014: Opinion and territorial split demonstrated with the bounded confidence XY model, parametrized by Twitter data. *Royal Society Open Science*, *5*(8), 171935. https://doi.org/10.1098/rsos.171935

Scheid, J. L., Lupien, S. P., Ford, G. S., & West, S. L. (2020). Commentary: Physiological and Psychological Impact of Face Mask Usage during the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health*, *17*(18), 6655. https://doi.org/10.3390/ijerph17186655

Sharma, M., Yadav, K., Yadav, N., & Ferdinand, K. C. (2017). Zika virus pandemic—Analysis of Facebook as a social media health information platform. *American Journal of Infection Control*, *45*(3), 301–302. https://doi.org/10.1016/j.ajic.2016.08.022

Sloan, L., & Morgan, J. (2015). Who Tweets with Their Location? Understanding the Relationship between Demographic Characteristics and the Use of Geoservices and Geotagging on Twitter. *PLoS ONE*, *10*(11), e0142209. https://doi.org/10.1371/journal.pone.0142209

Sloan, L., Morgan, J., Housley, W., Williams, M., Edwards, A., Burnap, P., & Rana, O. (2013). Knowing the Tweeters: Deriving Sociologically Relevant Demographics from Twitter. *Sociological Research Online*, *18*(3), 74–84. https://doi.org/10.5153/sro.3001

Statistics Canada. (2020). *Majority of Canadians intend to get the COVID-19 vaccine, September 2020.*https://www150.statcan.gc.ca/n1/daily-quotidien/201217/dq201217c-eng.htm

Tavernise, S. (2020, November 30). It may be weeks before we know if Thanksgiving travel fed a virus surge. *The New York Times*. https://www.nytimes.com/2020/11/30/world/thanksgiving-coronavirus-us-spread.html

Turetsky, K. M., & Riddle, T. A. (2018). Porous Chambers, Echoes of Valence and Stereotypes: A Network Analysis of Online News Coverage Interconnectedness Following a

Nationally Polarizing Race-Related Event. *Social Psychological and Personality Science*, *9*(2), 163–175. https://doi.org/10.1177/1948550617733519

Vicario, M. D., Gaito, S., Quattrociocchi, W., Zignani, M., & Zollo, F. (2017). News Consumption during the Italian Referendum: A Cross-Platform Analysis on Facebook and Twitter. *2017 IEEE International Conference on Data Science and Advanced Analytics (DSAA)*, 648–657. https://doi.org/10.1109/DSAA.2017.33

Voit, E. O. (2019). Perspective: Dimensions of the scientific method. *PLoS Computational Biology*, *15*(9), e1007279. https://doi.org/10.1371/journal.pcbi.1007279

Warth, G. (2020, June 2). San Diego resident sues county over mask orders. The San Diego Union-Tribune. https://www.sandiegouniontribune.com/news/health/story/2020-06-02/palomar-health-worker-sues-county-over-masks-orders

Wang, J., Pan, L., Tang, S., Ji, J. S., & Shi, X. (2020). Mask use during COVID-19: A risk adjusted strategy. *Environmental Pollution (Barking, Essex: 1987)*, *266*(Pt 1), 115099. https://doi.org/10.1016/j.envpol.2020.115099

Weber, I., Garimella, V. R. K., & Batayneh, A. (2013). Secular vs. Islamist polarization in Egypt on Twitter. *Proceedings of the 2013 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining*, 290–297. https://doi.org/10.1145/2492517.2492557

Widdicombe, S., & Wooffitt, R. (1995). *The language of youth subcultures: Social identity in action*. Harvester Wheatsheaf.

Williams, H. T. P., McMurray, J. R., Kurz, T., & Hugo Lambert, F. (2015). Network analysis reveals open forums and echo chambers in social media discussions of climate change.

Global Environmental Change, *32*, 126–138. https://doi.org/10.1016/j.gloenvcha.2015.03.006

Xiao, J., Shiu, E. Y. C., Gao, H., Wong, J. Y., Fong, M. W., Ryu, S., & Cowling, B. J. (2020). Nonpharmaceutical Measures for Pandemic Influenza in Nonhealthcare Settings—Personal Protective and Environmental Measures. *Emerging Infectious Diseases*, *26*(5), 967–975. https://doi.org/10.3201/eid2605.190994

Yarmol-Matusiak, E. A., Cipriano, L. E., & Stranges, S. (2021). A comparison of COVID-19 epidemiological indicators in Sweden, Norway, Denmark, and Finland. Scandinavian Journal of Public Health, 49(1), 69–78. https://doi.org/10.1177/1403494820980264

Zhang, Y. S. D., Noels, K. A., Young-Leslie, H., & Lou, N. M. (2022). "Responsible" or "Strange?" Differences in Face Mask Attitudes and Use Between Chinese and Non-East Asian Canadians During COVID-19's First Wave. *Frontiers in Psychology*, *13*. https://www.frontiersin.org/article/10.3389/fpsyg.2022.853830

Zhang, R., Li, Y., Zhang, A. L., Wang, Y., & Molina, M. J. (2020). Identifying airborne transmission as the dominant route for the spread of COVID-19. *Proceedings of the National Academy of Sciences of the United States of America*, *117*(26), 14857–14863. https://doi.org/10.1073/pnas.2009637117

Zhang, Y. S. D., Young Leslie, H., Sharafaddin-zadeh, Y., Noels, K., & Lou, N. M. (2021). Public Health Messages About Face Masks Early in the COVID-19 Pandemic: Perceptions of and Impacts on Canadians. *Journal of Community Health*, *46*(5), 903–912. https://doi.org/10.1007/s10900-021-00971-8

Zimmermann, B. M., Eichinger, J., Schönweitz, F., & Buyx, A. (2021). Face mask uptake in the absence of mandates during the COVID-19 pandemic: A qualitative interview study with

Swiss residents. *BMC Public Health*, *21*(1), 2171. https://doi.org/10.1186/s12889-021-12215-4

Appendix

Identifying Canadian Twitter Users Using Classifiers

Co-authored with Veronica Slam and Dr. Denilson Barbosa

To determine face mask attitudes of Canadian users on Twitter, we used filters to extract likely-Canadian users and the mask-related tweets they likely made. First, we used a simple rule-based approach to automatically extract Canadian users from the dataset. 40,391,337 users, who have cumulatively written over 400 million tweets between January 1 and September 30, 2020. Then, our filter considered users as Canadian when their account details satisfied one of the following: (1) the user had at least one tweet geotagged in Canada, (2) the user location in the user's profile contained the word "canada", the name of a province or territory, and/or the name of a major Canadian city, or (3) a Canadian-indicative term appeared in the user's profile description. Canadian-indicative terms included demonyms such as "canadian", "albertan", or "torontonian", as well as the Canadian flag emoji. After using this filter to scan all tweets from January 21 to September 30, 2020, we found 566,669 users who satisfied these criteria. These users had written a total of 11,705,591 tweets. All these tweets were pushed to a set of new indices in Elasticsearch.

Next, we manually classified the filtered users and tweets for the purpose of training two classifiers. With assistance from upper-level undergraduate and graduate students from the Department of Psychology we collected a manually classified dataset of 923 users that were classified as either Canadian or not Canadian. To determine users' nationality, we instructed the students to examine users' Twitter profiles on a standard browser to investigate profile photo, description, location, and tweets produced by the user to make their decision. The two classifiers we trained used Naive Bayes and K-Nearest Neighbours classification (using the Universal

Sentence Encoder for the latter method to convert each input text into a high-dimensional vector). For the user Naive Bayes classifier, we used frequency-based feature selection to select the top 47000 features. The feature selection parameters were found by tuning, using 5-fold cross validation and accuracy on the training data sets as the evaluation metric. The Canadian user filter was evaluated by inspection, and the vast majority of users (approximately 85%) returned were Canadian.