

Digital Quarantine: Does Social Distancing Lead to Virtual Distancing?

By

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A Thesis Submitted to

Saint Mary's University, Halifax, Nova Scotia

in Partial Fulfillment of the Requirements for

the degree of Masters of Applied Health Services Research.

May, 2021, Halifax, Nova Scotia

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Abstract

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During the COVID-19 pandemic, public health officials actively promoted messaging on quarantine, isolation, and social distancing to reduce viral transmission and keep people safe. This paper examines the possibility of spillover effects that isolation-oriented interventions may have in a non-physical domain, specifically digital behaviors. While users indeed spend more time online during the pandemic, this may also manifest as a meaningful change in digital behaviors—people are engaging less online. Evidence from four studies reveal that users are sharing less news content, commenting less on discussion boards, engaging less with popular social media accounts, and even changing their search query behavior to fulfill peripheral safety needs (i.e., anti-virus software) in the wake of the pandemic. This paper documents an unintended consequence of isolation rhetoric in health promotion and, by identifying changes to our digital behaviors, this paper suggests ways to develop interventions to bolster social connectedness and collective mental health.

May 26, 2021

Acknowledgements

The assistance and encouragement from Dr. Ethan Pancer throughout my undergraduate and now graduate studies have been paramount to my progress in research. His dedication to helping me learn and succeed as a young researcher over the past five years have tremendously accelerated my understanding of the academic process from ideation to publication. I need to thank Dr. Pancer not only for his help in crafting this thesis but for the thousands of hours spent working one-on-one with me to develop invaluable research, career, and life skills.

I greatly appreciate the time, feedback, and help provided by my committee members Dr. Michael Zhang and Dr. Matthew Boland as I bumped my way through the process of submitting this thesis. And to Dr. Matthew Philp for his assistance as the external examiner for my defense. As well, thank you to Dr. Lucie Kocum for help keeping me on track to an eventual graduation.

Finally, thank you mom and dad for always supporting my constant life plan shifts and prolonged endeavor at academic study. Answering much needed phone calls, providing a roof over my head, and filling my stomach have been vital pieces to the completion of this research.

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Chapter 1

Introduction and Conceptual Development

1.1 The COVID-19 Pandemic

The novel coronavirus, COVID-19, was first discovered in Wuhan, China near the end of 2019. As a member of the severe acute respiratory syndromes, COVID-19 is also referred to as SARS-CoV-2. The disease is believed to spread by the transfer of infected, contaminated droplets from one person to another. These droplets can be transferred via close contact (i.e. sneezes and coughs), touching contaminated surfaces (i.e. handrails), or even greetings like hugs and handshakes (Government of Canada, 2021). Officially declared on March 11, 2020, the ever evolving global pandemic of COVID-19 has resulted in millions of infections and deaths. The spread of COVID-19 has been confirmed in at least 223 countries and has forced transportation systems and economies to near stand-still levels (World Health Organization, 2021b).

Despite the drastic declines experienced in global market production levels there have been exponential uptakes in virus-related consumption. For example, consumption of sanitization items such as disinfectants and face masks have increased to stock-out levels in many global regions (Togoh, 2020). Fear of the inability to acquire essential items drove sales for even toilet paper over short-term supply capacity (Garbe et al., 2020). However, as the pandemic evolves, regional governments are attempting re-opening strategies with varied levels of success (Hobbs, 2020). These plans commonly

involve the requirement (or at least recommendation) for mandatory face mask wearing in public places along with stringent indoor person capacity limits (Jerrett, 2020).

As regulation adapts to meet the current (or potentially new) normal for social interaction, corporations are working quickly to fill newly created gaps in the market. Not only are essential products (i.e. hand sanitizer, face masks, etc.) experiencing large increases in demand but luxurious variations in previously basic goods are becoming popular. Manufacturers such as Under Armour, Adidas, and Italian luxury label Off-White have developed designer face mask options. These masks offer consumers stylish face coverings that stand out from the typical disposable and low-cost cloth alternatives. Many distilleries started bottling expensive hand sanitizer during the shortage while hockey helmet companies like Nike-Bauer started creating high-quality clear face shields.

Despite the significant shifts and changes happening globally due to the pandemic, viruses and diseases are not a new concept for the world. The Black Death, Spanish Flu, Ebola Outbreak, and Zika Virus are all examples of tough global epidemics that the health community has been able to deal with. However, these diseases have either lacked the scale and reach of COVID-19 or occurred during a time of a less connected global society (CDC, 2018). This paper considers the impact that a pandemic has in the globally connected society of 2020.

1.1.1 Social distancing as a government intervention

The World Health Organization advises the public to adhere to specific interventions as an attempt to help slow the spread of COVID-19. These precautions

include thorough and frequent handwashing/sanitizing, avoiding touching your face, covering coughs and sneezes, staying home/self-isolation for anyone with suspected symptoms, and maintaining a physical distance between yourself and others around you (World Health Organization, 2021a). Governments have embraced the recommendations of the World Health Organization and have implemented guidelines and laws to help slow the spread within their own jurisdictions.

The Government of Canada suggests that COVID-19 is spread either through close contact (i.e. sneeze or cough), contaminated surfaces (i.e. touching a handrail), or common greetings (i.e. handshakes). In alignment with recommendations from the World Health Organization, Canada also suggests avoiding crowded spaces, frequent handwashing/sanitizing, and covering coughs and sneezes (Government of Canada, 2021). To further prevent the spread of COVID-19 the Canadian Government has put a limit on non-essential travel outside of the country and even across some provincial borders. Travelers required to cross these borders are given mandatory 14-day quarantine orders and those caught in violation of such policies have been issued minimum \$1,000 fines (CBC News, 2020).

Canada also encourages companies to develop work from home plans for employees. This practice has led to surges in uptake for online video conferencing software such as Zoom (Bond, 2020). However, for times where citizens most go out in public, the Government of Canada (along with the World Health Organization) recommends the use of a face covering. As it is believed that COVID-19 spreads through

transmitted droplets (i.e. sneezing, coughing, talking), breathable face masks that cover your mouth and nose are even mandatory in many Canadian provinces. Quebec has been the first province to begin handing out monetary fines for those not cooperating with face covering policies (Mignacca, 2020).

Practicing proper hygiene, working from home, and wearing a face mask are all Government interventions aimed at reducing the spread of COVID-19. However, one of the most popular intervention terms referenced is the practice of social distancing. Social distancing is proven to be one of the most effective ways to reduce the spread of illness during an outbreak. Societies have been slowing the spread of COVID-19 by making a conscious effort to keep a physical distance between each other. This means making changes in people's everyday routines in order to minimize close contact with others, including: avoiding crowded places and non-essential gatherings, avoiding common greetings (i.e., handshakes), limiting contact with people at higher risk, and keeping a distance of at least 2 arms lengths (approximately 2 meters) from others as much as possible (World Health Organization, 2021a).

Governments and citizens that embraced social distancing from the start are testaments to the success that such an intervention offers. For example, Taiwan, Vietnam, and New Zealand were among some of the first countries to be infected with COVID-19 yet they were able to defy predictions and quickly flatten the spread curve (Bengali & Jennings, 2020). Despite the success of these three countries, not all regions have been as successful implementing social distancing plans. Although "social distancing" is a well-

recognized term in the United States, the country has suffered greatly with spread of the virus. As of September 2020, the USA had identified more than 28 million cases (about 85,000 cases per million population versus 25 cases per million in Vietnam).

Epidemiologist Nadia Abuelezam from Boston College suggests that one reason America has been so greatly impacted is the implementation of “leaky” social distancing policy (Levenson, 2020). With much of the decision-making being managed at the state level, spotty rules and enforcement have been present in the country. Abuelezam suggests that lax shut-down guidelines from the federal Government left states to try to derive plans on their own, leading to this notion of a “leaky” social distancing intervention (Levenson, 2020). The clear contrasts between social distancing implementation and resulting infection spread rates in countries like Vietnam versus the United States strongly point to the importance for effective intervention strategies.

1.1.2 The rhetoric of social distancing versus physical distancing

The term social distancing has become the more commonly used form to discuss physical distancing (CDC, 2020). The main intention of physical (social) distancing has been to encourage citizens to stay at least 2 metres apart in all possible social interactions. However, some psychologists argue that social distancing implies other restrictions while physical distancing speaks more directly to the purpose of the policy (Geisinger, 2020). Psychologist Dr. Shahida Fareed argues that the term “physical distancing” simplifies the concept down to the actual important intention of social distancing (Geisinger, 2020). Dr. Fareed suggests that the implications of a social disconnect are potentially dangerous for

our mental health and the use of physical distancing is much appropriate in reference to disease spread prevention.

This sentiment of physical distancing as a more appropriate term than social distancing has been reiterated by health professionals as well. Dr. Maria Van Kerhove from the World Health Organization states that physical distancing from each other is “absolutely essential” but that it is important to remain connected (Jones, 2020).

1.2 Conceptual metaphors

When COVID-19 reached widespread human-to-human transmission in early 2020, a pattern of seemingly-related, but inaccurate trends emerged. Reports suggested that consumers were no longer drinking Corona beer (Kotoky, 2020) or eating Chinese food (Williams, 2021) – both of which are factually untrue and unrelated to the illness. But common references from governments and news media to the coronavirus or the Chinese virus spilled over into unrelated domains, a process referred to as metaphorical transference. According to Conceptual Metaphor Theory, metaphors can shape thought by borrowing knowledge of a concrete concept to understand and relate to an abstraction, despite their differences. Supporting this claim is growing evidence that exposure to metaphoric messages prompts recipients to construe the metaphor’s abstraction in ways that are analogous to the salient concrete concept (see Landau et al., 2018 for a review). Experimental evidence has validated multiple metaphors including hope is light (i.e., participants that feel hopeless prefer brighter light bulbs; Dong et al., 2015), moral is clean (i.e., participants that feel immoral have a desire to wash their hands; Zhong &

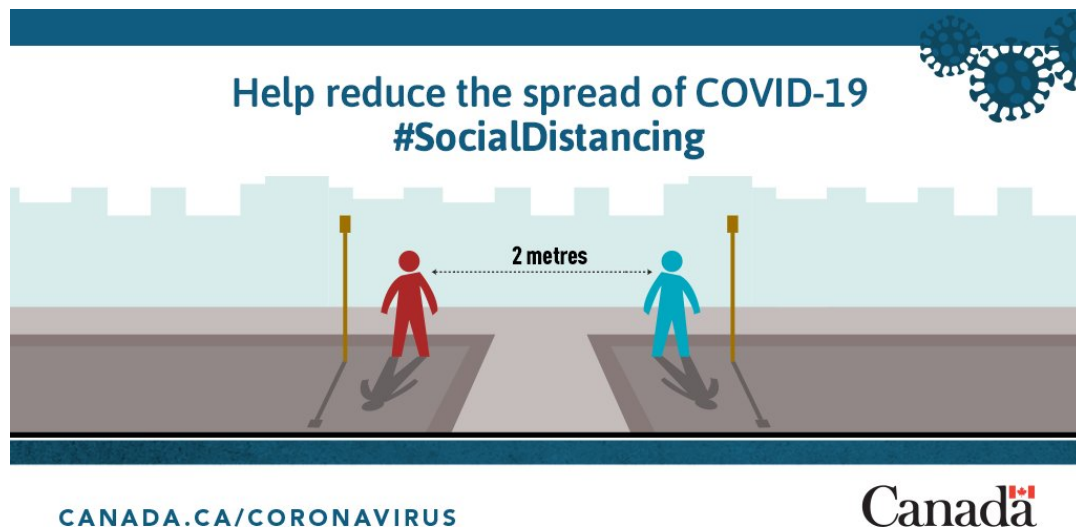
Liljenquist, 2006), and important is heavy (holding a heavy weight can increase the importance of an unrelated judgment; Jostmann et al., 2009).

1.3 The “isolation-as-safety” metaphor

Relevant to the current context is the conceptual metaphor of social proximity is warmth. Studies show that people represent friendly, welcoming qualities with warm temperatures and unfriendly qualities with coldness (Landau et al., 2018). Experiences of loneliness and social rejection are closely associated with cold sensations (Zhong & Leonardelli, 2008). In fact, people who have just been socially rejected report feeling colder than those who are not rejected (Ijzerman et al., 2012). In conjunction with social closeness as feeling warmth, removing opportunities to socialize can make people naturally feel colder and more alone. As people adapt to their new normal of pandemic life, evidence on conceptual metaphors suggests that they may not always see through a lens of rationality. Various sources of sensory-related language and imagery can activate metaphoric associations that shape attitudes and choices in subtle yet powerful ways.

This paper suggests that physical distancing recommendations by the federal government and laws enforced by the provincial government actively promote an isolation is safety metaphor. Not only is this salient in the language of social distancing, but also the visual messaging (Figure 1).

Figure 1 – Social Distancing Infographic from the Public Health Agency of Canada



This is also consistent with the language and imagery of self-isolation, which suggests solitude and loneliness (Figure 2). While physical distancing can limit spread and help flatten the curve to optimize healthcare resources, the spillover effects to other social domains are nascent at best. Self-isolation has been linked to negative psychological effects including post-traumatic stress symptoms, confusion, and anger (Brooks et al., 2020). Social isolation can breed fear, which in turn, can make people overly isolate even in non-physical domains.

Figure 2 – Solitary imagery on “How to Quarantine (Self-Isolate)...” from the Public Health Agency of Canada



1.4 Digital behaviors

Government guidelines for social distancing often include the recommendation to stay at home. Simply remaining in your own home and avoiding public spaces as much as possible is believed to significantly limit the spread of disease. Encouraging citizens to remain home can have positive impacts on COVID transmission rates but what are people doing when quarantining in their house?

As social beings, being apart from one another is challenging. While physical distancing is known to help limit disease spread and reduce the load on hospitals, it is unclear what the psychological impact of social quarantine is and how isolation is shaping other behaviours/mental health. With federal and provincial/state health agencies promoting quarantine, isolation, and physical distancing as a means to keep safe during the pandemic, it is possible that the impact of isolation-oriented messages may spill over into non-physical domains. For example, our online actions like reading the news,

searching for information, or browsing social media, can be unconsciously shaped by the notion of quarantine.

A surge in home baking led to many unexpected shortages of yeast and flour. New puzzlers largely spiked demand for puzzle sales with celebrities such as Ellen DeGeneres and Conan O'Brien even promoting the pastime (Dinges, 2020; Ferreira, 2020). However, internet usage, without question, witnessed a dramatic surge during at-home quarantine. Many companies switched to online communication platforms as physical shops closed and Netflix added 16 million new subscribers in the first three months of 2020 (more than double expected) (Lee, 2020). As people remained home, they turned to online devices and networks for work, entertainment, and communication. However, even though more people are online at one time, could they be using the platforms differently?

The concept of social distancing has been around for centuries to mitigate widespread disease outbreak (see Glass et al., 2006 for a review). But people are inherently social beings and eliminating opportunities to interact can pose a series of challenges. One might assume that the rise of virtual environments like Zoom and apps like House Party would be cathartic in satisfying pent up socializing needs, effectively supplanting routine social behaviors. However, recent work in *The Lancet* has highlighted the psychological impact of social isolation and quarantine, which include loneliness, reduced productivity, and the loss of multiple benefits linked to human interaction (Brooks et al., 2020).

Emerging research is starting to uncover the effects of quarantine and isolation (resulting from the COVID-19 pandemic) on people's mental health. Investigators have found evidence of psychological damage as a result of the prolonged quarantine and isolation measures. Implications include issues of post-traumatic stress, confusion, and anger (de Lima et al., 2020). These new findings encourage the issuance of stronger mental health support and policies for struggling populations around the world.

This paper posits that social distancing policies are creating unintended isolation behaviors in online contexts. Even though virus spread is not possible through internet use, the concept of isolation-as-safety is likely leading to spillover consequences as users interact with each other in various online networks. This is potentially creating issues for health systems and governments as studies have shown the potential benefits of social networks like Facebook in building and maintaining social capital (Johnston et al., 2013). Increased levels of social media usage and virtual connection with peers have been shown to improve psychological well-being and can help minimize risks for low self-esteem and life satisfaction (Johnston et al., 2013). Decreased online interaction, in a period of extremely limited physical interaction, may be a concern for our collective well-being during the pandemic.

1.5 Digital domains of interest

1.5.1 Google search trends

It is expected that the isolation-as-safety metaphor will manifest in multiple digital domains, specifically, search query behavior. Web search queries are text strings

of keywords sent to a search engine such as Google, Bing, etc. (Schumacher, 2020). Google is the largest search engine in the world with 91.86% global market share as of January 2021 (Statcounter, 2021). Google Trends is an analysis tool that reports behavioural shifts in search query behaviour. After COVID-19 was declared to be a global pandemic on March 11, 2020, it is predicted that search patterns for social activities will show a decline after social distancing policies were initiated. This is fairly intuitive given that public gatherings were banned in many regions as of this date. More importantly and consistent with the notion of isolation as safety, it is expected that personal protection queries to increase over the same period.

H₁: Search queries for digital protection will increase after social distancing protocols have been initiated.

1.5.2 Most followed Twitter accounts

The presence of social media networking services in 2020 is at its highest level ever (up 9.2% over 2019) (We Are Social, 2020). The social network Twitter has about 330 million active users curating almost 6 tweets every second (Iqbal, 2020). With such vast amounts of quality data readily available, Twitter has become an important source for numerous studies in countless academic research areas from marketing to medicine (Mahata et al., 2018; Pancer & Poole, 2016; Pershad et al., 2018). This field study looks at the top five most followed accounts on Twitter: @BarackObama, @justinbieber, @katyperry, @rihanna, and @taylorswift13. It is predicted that engagement by followers

of these accounts has declined significantly since the inception of social distancing policy on March 11, 2020.

H₂: Online engagement (likes and retweets) with tweets from top followed accounts will decrease after social distancing protocols have been initiated.

1.5.3 News article sharing

With 2.5 billion active global users, it is without surprise that Facebook can also provide rich insights to pandemic response behaviours during the COVID-19 outbreak. This field study focuses on online engagement (via the Facebook social networking site) with news articles from both before and after COVID-19 social distancing policies were enacted. Turning to the most used news sources in both Canada and the United States (CBC and CNN) this study predicts that sharing and discussion of news article links within the Facebook social networking site has decreased significantly since March 11, 2020. In line with the concept of isolation as safety, this paper predicts that Facebook users have become more hesitant to engage with each other (despite no real viral contamination risk) and therefore are interacting less on the site.

H₃: Online engagement (shares, likes, and comments per user) with news articles will decrease after social distancing protocols have been initiated.

1.5.4 Reddit community engagement through commenting

News and discussion network Reddit houses more than 430 million active users who have commented 1.7 billion times on almost 200 million posts (Roettgers, 2019). With such a large dataset available of up-to-date discussions, this final field study investigates the behavioural changes of Redditors pre and post the declaration of the COVID-19 pandemic. It is expected that declines in per user engagement (commenting) will occur on Reddit posts after March 11, 2020.

H4: Online engagement (comments per user) with Reddit submissions will decrease after social distancing protocols have been initiated.

Chapter 2

Studies – Method and Results

This thesis reports the findings from four field studies assessing how digital engagement behaviours have changed since social distancing protocols were enacted in 2020. Study 1 provides macro-level insights into changes in search query behavior pre and post-pandemic announcement. As evidence of the spillover of the isolation as safety metaphor, it is expected that an increase in searches for digital protection solutions will occur (i.e., anti-virus software) (H_1), even though its procurement would not protect against physical contamination. The other three studies examine relative (per user) changes in engagement in order to accommodate for the surge in increased web traffic during the pandemic. Study 2 examines a sample of tweets posted by top Twitter accounts in 2020 to measure if like, retweet, and comment metrics by followers decreased post-pandemic (H_2). Study 3 is a conceptual replication of Study 2 examining the effects on news media engagement, harvesting social media engagement metrics from Facebook to test if news articles from Canada (CBC) and the United States (CNN) were liked, commented upon, and shared less (H_3). Study 4 further tests the proposition with respect to digital community engagement, analyzing Reddit commenting as a form of engagement (H_4).

2.1 Study 1: Google Trends

2.1.1 Rationale

Observing digital consumer behavior has become increasingly easier since the inception of online tracking services such as Google Trends. With over 40,000 global queries every second and more than 90% market share, Google is undoubtedly the dominant search engine for online users (Jun et al., 2018). Logging more than 1.2 trillion searches each year, Google has access to valuable consumer insights that are coupled with various demographic, geographic, and date/time variables. Although much of this information stays proprietary, Google does release aggregated insights about search behaviour presented on a day-by-day timeline format. Google Trends was first introduced in 2006 and has provided marketers, researchers, journalists, and numerous interested parties with regionalized data to help answer questions, tell stories, and explain intriguing global phenomenon (Jun et al., 2018).

Study 1 harnesses the insights from Google Trends to assess changes in online behaviour from both before and after March 11, 2020. This study looks at day-by-day interest metrics for 2020 on both intuitive and somewhat counter-intuitive terms affected by the COVID-19 pandemic. The findings from Study 1 help establish that online behaviour (specifically search patterns) have changed significantly post the declaration of the global health pandemic. As well, Study 1 begins to investigate the isolation as safety metaphor where social distancing policy could be encouraging unintended side effects in virtual domains.

2.1.2 Method

The Google Trends online interface allows users to receive metrics for any given search term/topic. The outputted data can be filtered down into desired date ranges where interest scores are compared relatively. For example, if you want to see search interest in Facebook this week and Wednesday was the busiest day for the social network, Wednesday would receive a score of 100 and all other days of the week would be scored between 1-99 around it (note that there does not always need to be a 1 score but there will always be a 100 in a given date range sample).

One major influence of social distancing policy is the encouragement to stay home and avoid contact with other people as much as possible. Therefore, it is reasonable to believe that non-necessary social gatherings (i.e. for entertainment) should decrease dramatically when social distancing policies are in place. To assess this shift, the search term “bar” (under the category drinking establishment) has been included in Study 1.

Staying at home for large majorities of the day has not only led to increases in boredom and online media consumption (Lee, 2020), but it is reasonable that a lot of home repairs and improvement projects were taken on by homeowners that would otherwise have been completed by a professional. Study 1 includes the search term “do-it-yourself” or “DIY” as a proxy for changes coming from stay at home orders.

Finally, Study 1 also considers the impact social distancing policy could be having in a more unconventional sense. The increase of social distancing policy and related rhetoric encourages internal thoughts of spread and contagion. Constant thought about minimizing contact and isolation could lead to overlapping inferences in unrelated

(non-infectious) domains. To assess this concept, Study 1 analyzes the search term “Anti-Virus Software”. Changes (increases) in search behaviour for anti-virus software (i.e. Norton, McAfee, etc.) can indicate over-spilling of social distancing policy into areas not directly affected by COVID but share similar related attributes (i.e. computer virus infections). This pulls from the concept of isolation as safety where our conscious actions and thoughts throughout the day (constantly focusing on keeping physical distance and avoiding unnecessary touching of people and things) is possibly creating a new mindset that encourages similar thought processes even when not necessary. As people think less rationally about given situations and apply the broad reaching policies issued from government (i.e. social distancing) to all instances of their lives, it is possible to see a spillover of isolation practices in non-contagious domains.

2.1.3 Measures

Using the day-by-day metrics from Google Trends, all daily data regarding the three search terms of interest (bar, do-it-yourself, anti-virus software) was collected for the period of February 1, 2020 through May 31, 2020 (121 unique days). These dates were selected as Google Trends only allows for four months of daily data to be outputted (i.e. a 5 month window switches the output to weekly level detail). February 2020 through May 2020 generate a significant amount of dates from both pre and post the declaration of a global health pandemic (which corresponds fairly closely to the issuances of most state issued stay at home orders). To begin analyses, this data was plotted on a time scale chart with an interest point of March 11, 2020 highlighted to compare shifts in

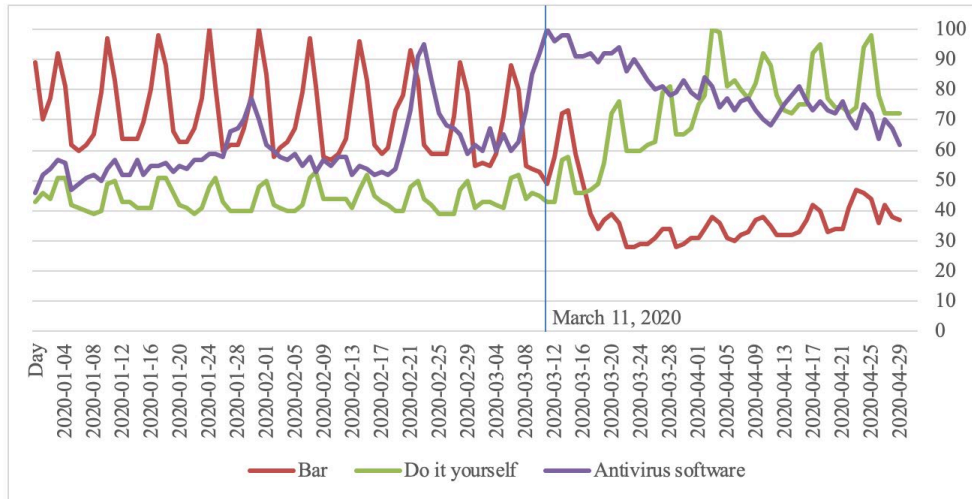
the data pre and post declaration of a global health pandemic. This quick, initial method of visual plotting of Google Trend data has been similarly used in published studies looking at product feature trends as a means of market predictions (Du et al., 2015). In the current work, visual trend identification is also paired with empirical analysis of the search term engagement via an independent samples t-test on two groups (pre and post March 11, 2020). As well, due to the availability of state level data from Google Trends, Study 1 takes a rigorous look into effects from relative stay at home order dates (per state) on the search terms through a generalized difference in differences regression analyses.

2.1.4 Results

The Google Trends data indicates directional changes that align with the predictions of H₁. As shown in the Figure 3, searches, or related searches, for the term “Bar” (drinking establishment specifically) have decreased noticeably since the announcement of a global health pandemic on March 11, 2020. This trend was expected as stay at home orders came into effect and governing policy encouraged only essential human-to-human contact. Interest in both “Do-It-Yourself” and “Anti-Virus Software” topics both showed large increases. As predicted, more people staying at home and unable to hire professional help could have positively impacted the interest scores for DIY searches. As well, the spike in anti-virus software indicates a potential initial discoverence of the isolation as safety metaphor effect. The increased interest in anti-

virus software could possibly be driven by more top of the mind contagion and virus spread ideas.

Figure 3 – Study 1: Google Trends Analysis of Relevant Search Terms



Splitting the data into two groups (pre and post March 11, 2020) allows for analysis via an independent samples t-test. For all three search terms (Bar, DIY, & Antivirus software), the t-test indicates corresponding (either positive or negative) significant differences in relative search term engagement post the declaration of a global health pandemic (as shown in Figure 4).

Figure 4 – Study 1: Independent Samples T-Test on Google Trend Analysis of Relevant Search Terms

	t	df	p
Antivirus Software	-11.957	119	< .001
Bar (Drinking Establishment)	15.027	119	< .001
Do It Yourself	-15.167	119	< .001

Note. For all tests, the alternative hypothesis specifies that group 0 (*Before March 11, 2020*) is not equal to group 1 (*After March 11, 2020*).

To control for possible effects from rival hypotheses, the implementation of a difference in differences regression analysis is used to further validate the findings in Study 1. The advantage of using the difference in differences approach is that this method attempts to mimic the process used in experimental trials consisting of treatment and control groups. In Study 1, this is possible by looking at state issued stay-at-home orders through the United States. The respective date for the state’s stay at home order will act as the “treatment”. This allows for analysis of both pre and post at a comparative state level. As well, eight states (Arkansas, Iowa, Nebraska, North Dakota, Oklahoma, South Dakota, Utah, and Wyoming) did not issue stay at home orders and can therefore be used as control states. The following generalized difference in difference specification is estimated,

$$Search\ Term_{s,t} = \alpha + \beta Stay\ At\ Home + \gamma_s + \vartheta_t + \varepsilon$$

$Search\ Term_{s,t}$ is the Google Trends measure for the three search terms: Bar, DIY, & Antivirus software. α is an intercept. β measures the effect of the stay at home order on the three search terms. γ_s is a state fixed effect and control for any unobserved time-invariant state-level factors that may influence internet searches. ϑ_t is a day fixed effect that controls for any macro-level shocks in the US that vary through time (day), or seasonality, at the daily level. ε is an error term. The inclusion of state and day fixed effects results in the difference in differences coefficient controlling for many potential omitted variables that may otherwise explain the results. For example, an alternative

causal channel explaining the results would have to be an omitted variable that correlates with the stay at home order, within state.

Data was collected between February 1, 2020 and May 31, 2020 for the same Google Trend measures as earlier (Bar, DIY, & Antivirus software) but this time at state level detail (51 states including D.C.). The state data was then aligned with its respective stay at home date (or control) and dummy variables were generated to demonstrate pre and post treatment. The 51 states and 121 days in the date range creates a sample size of 6,171 for each search term. Results from the differences in differences regression are shown in Figure 5.

Figure 5 – Study 1: Difference in Differences Regression on Google Trend Analysis of Relevant Search Terms

	DIY	Bar	Antivirus
Stay at Home	3.435*** (3.07)	-4.021** (-2.36)	3.711*** (2.83)
Intercept	41.06*** (80.47)	38.09*** (49.04)	19.99*** (33.49)
Day Fixed Effects	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes
Adjusted R-Square	0.598	0.611	0.221
N	6171	6171	6171
F-Test	9.403	5.559	8.016

Note. The table estimates whether internet search activity was affected by COVID-19 stay at home orders. The Stay at Home coefficient represents the interaction between the treatment and post date dummy. Dependent variable in the analysis is Google Trend daily interest score. Standard errors are clustered at the state level. *, **, and *** identify statistical significance at the 10%, 5%, and 1% level, respectively.

2.1.5 Discussion

The purpose of Study 1 is to illustrate significant shifts in basic online behaviour (Google searching) both pre and post the declaration of stay at home orders. Consistent with predictions in H₁, findings indicate that search queries related to digital protection and at home activities have increased while social event interest has declined. These shifts are apparent visually (Figure 3) and are robustly verified through statistical testing (Figure 4 and Figure 5).

The application of the T-Test does strongly indicate that there is a significant shift after the implementation of a global health pandemic. However, many seasonal correlated and unobserved variables may offer an alternative explanation. For example, DIY searches may generally increase over the period as spring weather entices home owners to take on renovation projects. To mitigate these concerns, the generalized difference in

differences specification is estimates. The strong significance of the Stay at Home coefficient, after controlling for fixed effects, suggests that the implementation of such policy had strong impacts on online search behaviour.

Study 1 also helps establish that March 11, 2020 is a significant date for comparing pandemic related shifts in online behaviour. Proving the importance of this date (in relation to COVID-19 datasets) assists in analysis of all further studies in this paper.

2.2 Study 2: Twitter

2.2.1 Rationale

The presence of social media networking services in 2020 is at its highest level ever. Social network Twitter has about 330 million active users curating almost 6 tweets every second (Iqbal, 2020). This is enough tweets to fill a 10-million-page book every day. This large corpus of data is curated largely by journalists and celebrities (Morrison, 2015). As well, 83% of world leaders actively use Twitter and, most recently, Donald Trump has been deemed the second most influential account on the social network (second to Taylor Swift) (Joyce, 2019; The Digital Policy Council, 2016).

Twitter's success in creating such a wealth of information from well-known individuals stems from the engaging aspects of the website (and social networks more broadly). The website allows users to instantly comment, share, like, and respond with content. Not only can these features enable captivating conversations amongst users but accumulating likes and shares on personal content can have impacts on levels of self-

esteem (Andreassen & Pallesen, 2014). Factors that can lead to social network addiction through a dependency of self-affirmation via post interaction (like counting) (Andreassen & Pallesen, 2014; Martinez-Pecino & Garcia-Gavilán, 2019).

2.2.2 Method

This field study looks at the top five most followed accounts on Twitter: @BarackObama, @justinbieber, @katyperry, @rihanna, and @taylorswift13. All tweets published by these five accounts from January 1, 2020 through April 30, 2020 were collected along with respective variables including like, comment, and retweet counts for each post. This generated a corpus of 861 unique tweets with an average of 57,616 likes, 1,805 comments, and 9,942 retweets on each original tweet.

To assess online engagement, the use of Twitter interaction measures are used in this study. These include counts of likes, comments, and retweets for all 861 posts. This data was downloaded using the Twitter API via a custom Python script to collect the data into a spreadsheet format for analysis. A very small number of tweets generated a disproportionately high number of engagement which positively skewed our data. To account for the positive skewness, the natural logarithm of all engagement metrics was calculated (likes, comments, retweets) for use as dependent variables.

2.2.3 Measures

The dataset was grouped into two categories based on the date of March 11, 2020. This was the official date that the World Health Organization declared a global pandemic and social distancing guidelines increased intensity. All articles posted before March 11,

2020 were assigned a zero value (Group 0) and all posts on or after that date were assigned a one value (Group 1). This splitting of the data allows for an independent sample t-test to be performed. Testing that engagement in Group 0 is greater than Group 1 addresses H_2 in that a significant difference would indicate reduced sharing after an increase in social distancing policy.

Numerous data sources have indicated large increases in online and social media usage since policies encouraging citizens to stay home have been enacted (eMarketer, 2020; Nielsen, 2020). In order to account for this spike in online traffic the engagement metrics were also distributed against their respective date's internet traffic. This traffic metric comes from the Google Trend interest score regarding the Twitter website. The day-by-day indicator of relative interest in Twitter was used as a proxy to indicate traffic to the website each day. The logarithmic values of all engagement metrics were divided against their respective Google Trend day-by-day interest score to generate logarithmic like, comment, and retweet per traffic variables.

This approach for approximating daily interest in a topic has been used similarly by Stephen & Galak (2012) in order to determine effects of earned publicity on sales with microlending site Kiva. Stephen & Galak (2012) used the daily traffic/interest metric from Google as a representation for the respective dates' publicity about a given topic.

2.2.4 Results

The directional independent samples t-test indicates a $p < 0.001$ significance level for all engagement per traffic metrics (likes, comments, retweets). For all tests, Group 0

was shown to be significantly larger than Group 1 indicating that online engagement, post increases in social distancing measures, has decreased significantly.

Figure 6 – Study 2: Independent Samples T-Test on Twitter Engagement with Top Accounts

	t	df	p
log_replies/traffic	9.650	861	< .001 ^a
log_retweets/traffic	10.744	861	< .001 ^a
log_likes/traffic	12.145	861	< .001 ^a

Note. For all tests, the alternative hypothesis specifies that group 0 (*Before March 11, 2020*) is greater than group 1 (*After March 11, 2020*).

2.2.5 Discussion

Study 2 demonstrates a significant decrease in online engagement post the declaration of a global health pandemic. Findings indicate that user interaction with tweets made by popular accounts relatively decreased across all metrics of liking, commenting, and retweeting after March 11, 2020. This shift shows an initial indication that, despite increased online users (Nielsen, 2020), relative sharing and engaging activities have decreased alongside widespread promotion of social distancing. To ensure the robustness of this finding, similar tests are repeated across alternative domains and datasets in Study 3 and Study 4 of this paper.

2.3 Study 3: News and Facebook

2.3.1 Rationale

Study 3 focuses on online engagement (via the Facebook social networking site) with news articles from both before and after COVID-19 social distancing policies were

enacted. Nielsen (2020) reports suggest that television news media consumption increased up to 60% during stay-at-home orders related to the COVID-19 pandemic. This effect was replicated across many countries depending on the stage of virus spread they were in (Nielsen, 2020). Many researchers have turned to news media data and its role in the pandemic. Researchers from Russia have discovered that during the pandemic, such increased news media consumption is potentially impacting (increasing) citizens' levels of anxiety (Nekliudov et al., 2020). Researchers from the United States discovered that polarizing politics and news media consumption is difficult for building trust in health care experts and could have led to prejudices towards Asian Americans (Dhanani & Franz, 2020). News media is most definitely an important part of pandemic response and information dissemination. This study considers the impact that social distancing policy and contagion awareness could be having on sharing and engaging with news articles via the Facebook social network.

2.3.2 Method

A custom web scraper was developed to gather information on every news article published between January 1, 2020 and March 31, 2020 by the CBC News corporation in Canada (6,275 articles) and by CNN in the United States (19,309 articles). To assess online engagement, the use of Facebook interaction measures are used in this study. These include counts of shares, comments, and reactions (i.e. likes) for all news articles. This data was collected using the SharedCount API which provides social media engagement metrics for given URL's.

Similar to Study 2, a very small number of articles generated a disproportionately high amount of engagement which positively skewed our data. To account for the positive skewness, the natural logarithm of all engagement metrics was again calculated for use as dependent variables. Allowing for increases in traffic to the website, the Google Trend interest scores were used for CBC and CNN to distribute each day's engagement metrics against.

2.3.3 Measures

The measures for Study 3 remain the same as the measures used in Study 2 except the dependent variables shift from likes, comments, and retweets (Twitter terminology) to reactions, comments, and shares (Facebook terminology). The same cut-date of March 11, 2020 was used to perform an independent samples t-test. Traffic scores were generated based on daily Google Trend interest metrics for Facebook. Engagement metrics were scored using natural logarithms.

2.3.4 Results

The directional independent samples t-test indicates a $p < 0.001$ significance level for all engagement per traffic metrics (reactions, comments, shares). For all tests, Group 0 was shown to be significantly larger than Group 1 indicating that online engagement, post increases in social distancing measures, has decreased significantly.

Figure 7 – Study 3: Independent Samples T-Test on Facebook Engagement CBC News Articles

	t	df	p
log_shares/traffic	6.840	89	< .001
log_comments/traffic	7.158	89	< .001
log_reactions/traffic	7.455	89	< .001

Note. For all tests, the alternative hypothesis specifies that group 0 (*Before March 11, 2020*) is greater than group 1 (*After March 11, 2020*).

Figure 8 – Study 3: Independent Samples T-Test on Facebook Engagement with CNN News Articles

	t	df	p
log_shares/traffic	4.213	89	< .001
log_comments/traffic	4.215	89	< .001
log_reactions/traffic	4.214	89	< .001

Note. For all tests, the alternative hypothesis specifies that group 0 (*Before March 11, 2020*) is greater than group 1 (*After March 11, 2020*).

2.3.5 Discussion

Study 3 further replicates findings from Study 2 in that online engagement, post the declaration of a global health pandemic, has decreased despite increases in online user counts. Studies 2 and 3 both indicate a significant downward shift in per user online engagement (likes, shares, comments, etc.) after the global pandemic was declared and social distancing policy increased. Despite recommendations for the importance of continued social interaction from health professionals, it's plausible that the notion of isolation of safety (spillover into non-contagious domain of social networks) is contributing to the decreases witnessed here. Addressing the context of Facebook helps ensure findings from Study 2 (Twitter) hold in other social media networks and are not

specifically a product of the Twitter platform. Study 4 furthers this look into the Reddit platform on a much larger corpus of data.

2.4 Study Four: Reddit

2.4.1 Rationale

Reddit, or “the front page of the internet”, is an online discussion forum website (and mobile application) featuring a large variety of topics and interests. The website is divided into subreddits (self-assembled communities) which host topics, pages, questions, and comments related to the respective subreddit theme (i.e. gaming, books, jokes, etc.). Each Reddit post or comment can contain up to 40,000 characters although the most popular contain less than 120 characters (Simmonds, 2018). The more than 430 million monthly active users spend about ten and a half minutes on the site each time they visit (Roettgers, 2019). This large corpus of rich text data allows for the final study in this paper to harness very large amounts of row data (millions of rows) and replicate the findings within a forum context. As well, the analysis of a slightly different engagement measure (comments within a discussion forum) for Study Four enable the arguably most accurate indicator of involved engagement metrics within social media networks.

2.4.2 Method

Using the PRAW (Python Reddit API Wrapper) package along with a customized Python script all submissions were downloaded, along with respective variable data, from January 1, 2020 through April 30, 2020 for the top 5 subscribed to subreddits. These subreddits included r/funny, r/AskReddit, r/gaming, r/aww, and r/pics for a total of

1,518,418 submissions with 17,046,047 comments (between the two specified date ranges).

2.4.3 Measures

The measures for Study 4 remain the same as the measures used in studies 2 & 3 except the dependent variable is solely comments in the Reddit analysis. The same cut-date of March 11, 2020 was used to perform an independent samples t-test. Traffic scores were generated based on daily Google Trend interest metrics for Facebook. Engagement metrics were scored using natural logarithms.

2.4.4 Results

The directional independent samples t-test indicates a $p < 0.001$ significance level for the comments per traffic (engagement) metric. Group 0 was shown to be significantly larger than Group 1 indicating that per user online engagement (through number of comments per post), after increases in social distancing measures, has decreased significantly.

Figure 9 – Study 4: Independent Samples T-Test on Reddit Engagement

	t	df	p
log_comments/traffic	86.742	89	< .001

Note. For all tests, the alternative hypothesis specifies that group 0 (*Before March 11, 2020*) is greater than group 1 (*After March 11, 2020*).

Chapter 3

General Discussion

The COVID-19 pandemic has caused great uncertainty and change for citizens, health care workers, and many industries. Public health organizations around the world have been forced to act quickly and effectively in an international battle to help limit the spread of the virus. One of the most notable outcomes from this global effort was the popularization of the term “social distancing”. Despite the intention of encouraging citizens to remain 2 meters apart and avoid unnecessary social interaction, unintentional consequences of its use could include limited social interaction even in areas with zero risk of COVID contagion.

The continuous messaging to citizens about COVID-19 and the importance of social distancing is potentially causing online users to interact less. As citizens absorb recommendations to always be cautious of their surroundings, avoid unnecessary touching, and remain six feet apart from each other, it is plausible that we are instinctively acting more reserved in non-contagious settings. For example, users of online social networks in studies two through four in this work indicate significant decreases in per user engagement levels. This suggests that the notion of isolation as safety could be playing a role in the issuance of social distancing advertisements. Social distancing is encouraging concepts of solitude and isolation, consistent with past research, this easily plays into spillover effects in human behaviour as we adapt our thoughts and actions to follow recommendations from superiors.

The concept that isolation is creating a perceived shield of safety and impacting our intuitive behaviours is a possible explanation for the results found in this paper. However, it is notable to address drawbacks and potential alternative hypotheses. The dramatic surge in online consumption during quarantine lockdowns forced these studies to address per user engagement levels. Consequently, aggregate increases or decreases in online engagement could not be considered (i.e. likes, shares). Although averaging the interaction measures is presumably a fairly accurate indicator of engagement shifts it is not without its drawbacks. Firstly, the assumption that the Google Trends daily interaction score is a valid measure of per user level shifts is not explicitly proven. Extant research using Google Trends data have taken the score more directly into analyses (opposed to deriving an index with it). However, Google's own documents, indicating how the score is developed and the data it represents, suggest that the interpretation and application of the metric within studies two through four are meaningful.

Studies two through four found significant decreases in per user online engagement (across multiple social networks) post the declaration of a global health pandemic on March 11, 2020. This paper posits that a potential explanation for this result is due to increased contagion risk and social distancing advertisements leading to spillover effects in unrelated domains. However, one theory that could be explored and developed further in future studies could address the behaviour differences between users actively engaging in online social networks before March 11, 2020 versus the newcomers. Essentially, is it possible that stay-at-home orders forced more new active

people online and, if so, do these additional users engage less than previous active users? This would in turn cause daily Google Trend scores to go up and also decrease in per user interaction measures (assuming the influx of new users are not liking, commenting, and sharing as much as previous active users). The data accessed in this study did not allow for nuanced analysis amongst internet users but was solely on an aggregate scale. Future work could assess smaller groups of users from different categories (i.e. users frequently using social media before March 11, 2020 and users new to the platform around that date) to determine if interaction levels vary.

3.1 Conclusion

The COVID-19 pandemic has caused many apparent changes and shifts in the physical world around us. This paper has uncovered instances of potential spillover consequences in the digital realm from frequent pandemic related advertisements and health promotion material. Physical distancing policies and constant encouragement to avoid unnecessary social interaction are possibly creating a new mindset for citizens in situations even unsusceptible to COVID spread (i.e. online social networks). After the declaration of the global health pandemic on March 11, 2020, internet users have sought out more anti-virus programs and relatively decreased their social interaction even in platforms such as Facebook, Twitter, and Reddit. This idea that isolation is a form of safety, combined with a continuous conscious effort to avoid interaction, is potentially causing these unintended shifts in online behaviour. Changes that could lead to adverse side effects for one's wellbeing and mental health. We must be cautious of how policy

recommendations and health promotion material are going to be perceived and adapted by societies as we move forward in this pandemic.

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