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Understanding user responses to the COVID-19 pandemic on Twitter from a terror management theory perspective: Cultural differences among the US, UK and India

Soyeon Kwon [a], Albert Park [b,*]

[a] *Division of Digital Business, College of Global Business, Korea University, 2511 Sejong-ro., Sejong, 30019, South Korea*
[b] *Department of Software and Information Systems, College of Computing and Informatics, UNC Charlotte, Woodward 310H, 9201 University City Blvd, Charlotte, NC, 28223, USA*

A B S T R A C T

This study uses a new approach to understand people's varied responses to the COVID-19 pandemic. Heightened media coverage and surging death tolls undoubtedly increase individuals' death-related thoughts. Thus, this study draws on terror management theory to analyze the general public's reactions during which mortality is salient. Twitter data were collected from three countries—the US, the UK, and India. Topic modeling analysis using Latent Dirichlet Allocation identified a total of seven themes reflecting two types of defenses: proximal defenses and distal defenses. Proximal defenses included calls for behavioral changes in response to COVID-19. Distal defenses included searching for meaning, political polarization and government incompetence, racial division, and sharing up-to-date information. During a prolonged crisis, anxiety-buffering systems can be undermined and lead to either maladaptive defenses (i.e., psychological distress) or new forms of defenses (i.e., adjusting to the new normal). The analysis highlights cultural differences in defenses across the three countries. Theoretical and practical implications for public health practitioners and social media platform managers are then discussed.

1. Introduction

The World Health Organization declared the COVID-19 virus outbreak a global pandemic in Mayor, 2020 (Cucinotta & Vanelli, 2020). As of April 2021, the cumulative number of confirmed cases has reached 139 million globally and the death toll has now surpassed 3 million (Statista, 2021). In response to this global crisis, governments in most countries have imposed various quarantine measures to curb the spread of the virus. Often called 'lockdown', restrictions on public movement have led to unprecedented disruptions across every aspect of our lives, including business, education, and social interaction (Dwivedi et al., 2020). People have increasingly relied on social media to make sense of this crisis and communicate while maintaining social distance. Social media has therefore become an important source of information regarding the challenges of the pandemic and a vehicle for expressing and sharing thoughts and opinions (see Jurgens & Helsloot, 2018). Individuals' heavy reliance on social media motivated government officials worldwide to use it as a major communication tool, allowing them

not only to share up-to-date guidelines but also to boost citizens' morale (Rufai & Bunce, 2020). As a result, social media is an important data source that can provide insights into how people have responded to the COVID-19 pandemic.

Since the COVID-19 outbreak, there have been a growing number of studies that explore public responses to the pandemic using social media data (Abd-Alrazaq et al., 2020; Ahmed et al., 2020; Boon-Itt et al., 2020; Chandrasekaran et al., 2020; Xue et al., 2020). Among various social networking sites, Twitter has unique affordances that enable real-time information exchange on a large scale and collective sense-making based on shared sets of hashtags (Chang, 2010). Thus, Twitter is a powerful communication tool during crisis situations (Fischer-Preßler et al., 2019; Mendoza et al., 2010). As such, most recent studies analyzed Twitter data to understand public responses and concerns about the COVID-19 pandemic (e.g., Abd-Alrazaq et al., 2020; Chandrasekaran et al., 2020; Xue et al., 2020).

Nevertheless, previous studies have some limitations. First, most were based on tweets collected in the early stages of the pandemic,

which were analyzed from an infoveillance perspective, thereby limiting their analyses to health-related responses (e.g., Abd-Alrazaq et al., 2020; Boon-Itt et al., 2020; Xue et al., 2020). As the long-term impacts of the pandemic disrupt our daily life, various responses have arisen including pressures within the healthcare field, political divides (Deane et al., 2021; Perrett, 2020), and even racial tensions (Pyszczynski et al., 2020). Despite the importance of improving our knowledge regarding the impact of the pandemic on various sectors and counteracting potential negative impacts, most efforts have been directed towards examining health-related responses. This is the first research gap that this study aims to fill. Second, a knowledge gap still exists concerning the motivation behind certain observed responses due to a lack of theoretical underpinning (see also Kar & Dwivedi, 2020). While previous studies have mostly focused on empirically examining public responses to the COVID-19 outbreak (Abd-Alrazaq et al., 2020; Boon-Itt et al., 2020; Xue et al., 2020), less is known about why certain topics are often discussed. A few exceptions include a recent study by Pyszczynski et al. (2020) that provided a conceptual framework to explain people's reactions to the pandemic, but there is still a lack of empirical evidence supporting their propositions. Therefore, further research is needed to empirically examine public responses to the pandemic as well as to provide theoretical underpinnings to understand those responses. Third, most research efforts have been devoted to analyzing English data, thus limiting their scope to English-speaking individuals in predominantly western countries (Abd-Alrazaq et al., 2020). The impact of the COVID-19 pandemic has been felt on a global scale, meaning analyses based on data collected mostly from individualist cultures may lead to biased knowledge of people's responses to the pandemic. Therefore, more attention is needed to examine responses among people in collectivist cultures and to explore cultural differences in their coping strategies.

This study aims to address the aforementioned research gaps by exploring the most salient topics in COVID-19-related tweets from individualist and collectivist cultures as well as improving our understanding of public responses from a terror management theory (TMT) perspective. TMT provides a theoretical framework to explain how people cope with anxiety resulting from the awareness that death is inevitable (Pyszczynski et al., 1999). According to TMT, death-related thoughts can be managed by employing two types of defense strategies: proximal defenses, which are activated against conscious awareness of death-related concerns, and distal defenses, which are activated when these thoughts are not one's focal concern (Greenberg et al., 2000; Pyszczynski et al., 1999). The ever-increasing case and death toll statistics, coupled with media coverage highlighting the lethality of the novel coronavirus, increase the salience of concerns about death. People respond to this increased death-related anxiety in a variety of different ways. For example, people may actively seek preventive measures to manage the conscious awareness of their vulnerability (i.e., proximal defense). The long-term nature of the pandemic may increase death-related thoughts in the back of individuals' minds, resulting in other types of behaviors that bear no logical relationship with health but serve anxiety-buffering functions, such as engaging in prosocial behaviors and maintaining close relationships (i.e., distal defense) (Pyszczynski et al., 2020). Therefore, this study aims to identify the most salient topics in COVID-19 tweets concerning defense strategies in response to the pandemic's constant reminder of death, using topic modeling techniques and manual examination. It specifically addresses the following research question:

RQ1: What defense strategies stemming from TMT are employed by individuals to cope with death-related thoughts caused by the COVID-19 pandemic?

In addition, this study aims to compare and identify cultural differences in the defense strategies in response to death-related anxiety caused by the pandemic. Research on TMT has examined the cross-cultural validity of terror management defenses by comparing the differences between individualist and collectivist cultures (Du et al., 2013;

Kashima et al., 2004). Empirical evidence has demonstrated that cultural differences in major resources for managing death-related thoughts lead to different defense mechanisms (Du et al., 2013; Kashima et al., 2004). However, these cross-cultural differences have been mostly observed in laboratory settings and require further examination under real-life circumstances such as the COVID-19 outbreak. People in the US and UK are considered to belong to individualist cultures, while those in India belong to collectivist cultures (Kapoor et al., 2003). Our analysis aims to examine cultural differences in defense strategies by comparing responses among users from these three culturally distinct nations. This leads to our second research question:

RQ2: To what extent are defense strategies found among users in individualist cultures, such as the US and UK, different from those found among users in collectivist cultures, such as India?

The rest of the paper is structured as follows. First, a review of TMT and its implications for understanding various responses to the COVID-19 outbreak is provided. We then explain the analytical framework derived from TMT, which is used as a theoretical lens through which to analyze people's reactions to the pandemic. A review of previous literature on cultural differences within terror management is then undertaken. Next, we describe the collected Twitter datasets and the computational method employed in this study. The subsequent section provides the results of the analysis, including defense strategies found among users across the three countries (i.e., US, UK, and India) and their cultural differences. Finally, the paper concludes with discussions of main findings, theoretical and public health implications, and limitations that necessitate future research.

2. Theoretical and conceptual background

2.1. Terror management theory

TMT posits that people employ two coping strategies when they are exposed to anxiety resulting from the awareness that death is inevitable (Pyszczynski et al., 1999). The first, proximal defenses, are activated against conscious death-related thoughts. Proximal defenses are threat-focused and function to push these thoughts out of consciousness, either by addressing them in adaptive ways or engaging in cognitive distortions. These entail either rational problem-solving responses that reduce actual risk or defensive responses such as the denial of vulnerability and biased processing of personally relevant threatening information (Croyle et al., 1993; Liberman & Chaiken, 1992; for a review, see Pyszczynski et al., 1999). The second, distal defenses, protect against death-related thoughts on the fringes of one's consciousness or not in focal attention. Distal defenses, unlike proximal threat-focused defenses, deal with death-related anxiety in an indirect, symbolic manner by enabling people to construe themselves as valuable contributors to a meaningful world. Thus, these promote behaviors that seemingly bear no logical relationship with mortality awareness but serve anxiety-buffering functions, such as defenses of one's worldview, actions that boost self-esteem, and commitments to close relationships (Pyszczynski et al., 1999). Empirical evidence concerning worldview defenses includes a study by Arndt et al. (1997) which shows that American subjects exposed to death-related stimuli exhibit more favorable responses to those who support their worldview (e.g., pro-U.S. authors) and more unfavorable responses to those who threaten it (e.g., anti-U.S. authors). The increased salience of mortality also increases the use of various self-enhancement strategies (for a review, see Pyszczynski et al., 2004), such as self-serving attributions (Mikulincer & Florian, 2002), demonstrating skills and competencies for which one finds importance as a source of self-esteem (Arndt et al., 2003; Ben-Ari et al., 1999), donating to charities (Jonas et al., 2002), and purchasing high-status products (Mandel & Heine, 1999). In addition, based on the premise that self-esteem is strongly affected by the degree to which one is socially accepted or rejected by significant others (Leary et al., 1995), maintaining interpersonal bonds is another important source of

self-esteem and thus provides anxiety-buffering functions (Mikulincer et al., 2003).

Recently, TMT defense strategies were used to understand how people cope with anxiety engendered by threatening events in real-life situations (Fischer-Preßler et al., 2019; Yum & Schenck-Hamlin, 2005). For example, Yum and Schenck-Hamlin (2005) analyzed people's reactions to the 9/11 attacks in the US and showed that, consistent with previous research conducted in laboratory settings (e.g., Greenberg et al., 2000; Harmon-Jones et al., 1997), both proximal and distal defense strategies occur in real-life circumstances. The most commonly observed proximal defensive reaction was expressing shock or disbelief, while various distal defense strategies were highlighted, such as engaging in pro-social behaviors, searching for life's meaning and value, communication for information sharing purposes, and communication for relationship investment. TMT-based defenses were further validated at the collective level by analyzing tweets in response to the Berlin terrorist attack in Germany (Fischer-Preßler et al., 2019). Defenses observed among German Twitter users include searching for meaning and value, less tolerance and hostility toward different values, counter-bigotry activism, altruistic or pro-social behaviors, gratitude for helpers, and information seeking and sharing.

2.2. Terror management theory and the COVID-19 pandemic

Since March 2020 when the COVID-19 outbreak was declared as a global pandemic (Cucinotta & Vanelli, 2020), the lethality of the novel coronavirus has been highly salient in media coverage with ever-increasing cases and deaths being reported and vivid images capturing confusion and distress caused by the unpredictability of the unprecedented crisis (Sowden et al., 2021). This media coverage constantly reminds the public of death and vulnerability. The salience of mortality brought on by the COVID-19 outbreak has led to various responses from individuals, which can be explained under the TMT framework (Pyszczynski et al., 2020).

The terror management health model, which applies TMT to health-related judgments and behaviors, suggests that conscious awareness of death can promote health-oriented behaviors or denial and avoidance, both of which aim to remove thoughts of death from one's focal attention (Goldenberg & Arndt, 2008). Adaptive proximal responses entail following preventive measures suggested by medical communities such as social distancing and hand washing. Despite the mounting death toll and high level of media coverage which makes it hard to deny the situation, destructive proximal defenses are still used to trivialize the potential threat of the virus. This includes comparing it to the common seasonal flu (Ritter, 2020), attributing deaths from COVID-19 to other risk factors observed among those who are already at high risk of dying (Fox, 2020), or viewing the outbreak as a conspiracy (Ahmed et al., 2020; Kelland, 2021).

Given the long-term impacts of the pandemic on diverse aspects of human life, distal defenses focusing on maintaining one's cultural worldview, self-esteem, and close relationships are, for the most part, the way people manage death-related thoughts that are readily accessible but not in their current focal attention (Pyszczynski et al., 2020). The tendency to defend one's worldview results in a political divide, with conservatives endorsing conservative governments' (e.g., the Trump administration) handlings of the COVID-19 crisis and relaxed social distancing guidelines and liberals endorsing tighter restrictions (Deane et al., 2021; Perrett, 2020). This ideological division is also evident with regards to the Black Lives Matter (BLM) movement. Pyszczynski et al. (2020) argue that, although George Floyd's case was not the first unjust killing of a Black American by the police, the need to defend worldviews fueled by the pandemic intensified people's reactions to racial inequality. Furthermore, under circumstances where social gatherings are highly prohibited, people are motivated to maintain psychological proximity with friends and family members who provide them with psychological security (Courtet et al., 2020).

However, during an outbreak in which people are overwhelmed with threatening information, they may not be able to effectively manage death-related thoughts when anxiety-buffering systems are seriously undermined. The restrictions on social activities that were imposed to stop the spread of the virus have led to job and income loss, social isolation, and struggles with pursuing educational and career goals, all of which undermine important resources for managing death anxiety (Pyszczynski et al., 2020). This can lead to either maladaptive defenses in the form of psychological distress (Yetzer & Pyszczynski, 2019) or searching for new sources of meaning in life. For example, some people adjust to a 'new normal' way of life, embracing opportunities to explore new hobbies while maintaining distance (Brice-Saddler, 2020) or researching how businesses can survive during the pandemic (Davis, 2021).

2.3. Terror management responses to the COVID-19 pandemic

Seven themes are used to examine the first research question, exploring TMT-based defense strategies employed to cope with death-related thoughts brought on by the COVID-19 outbreak.

The first theme, *"calls for behavioral changes",* includes actions recommended by either government agencies or individuals to stop the spread of the coronavirus, such as social distancing, downloading tracking apps, or other preventive public health measures. Such health-oriented behaviors are expected when conscious death-related thoughts make people feel vulnerable to health risks (Goldenberg & Arndt, 2008). This is also in line with infoveillance studies showing that prevention methods are a major concern expressed by Twitter users during the pandemic (Abd-Alrazaq et al., 2020).

The second theme, "*searching for meaning*", refers to managing anxiety by imbuing one's life with meaning and significance. When faced with salient collective mortality, people have a tendency to search for meaning behind it and connect with others to build solidarity, which is frequently observed in online discourses after traumatic events (Fischer-Preßler et al., 2019). Consistent with previous studies supporting the anxiety-buffering function of self-esteem (Harmon-Jones et al., 1997), this study considers people's tendency to strive for self-esteem by enacting behaviors that encourage a sense of purpose, such as engaging in prosocial behaviors (Hirschberger et al., 2008), expressing gratitude (Fischer-Preßler et al., 2019), and fostering positive mindsets (Vail, 2012). Furthermore, people are likely to rely more on close relationships, which are another important source of meaning in life that help them feel secure in response to death reminders like COVID-19 (Mikulincer et al., 2003).

The third theme "*political polarization and government incompetence*" refers to hostile reactions against those that threaten one's worldview, including people with different political beliefs, and belief in the government's incompetent handling of the COVID-19 outbreak. This is in line with previous studies that explore political polarization in response to mortality salience (Burke et al., 2013; Pyszczynski et al., 2020). In particular, public distrust of the government tends to grow with policy mistakes, which makes the situation even more chaotic (Cairney & Wellstead, 2021).

The fourth theme "*racial division*" refers to ideological division in terms of race. As with the third theme, this is an outcome of people's tendency to protect their worldview in response to mortality salience (Greenberg et al., 1990; Pyszczynski et al., 2020). This has most notably taken the form of anti-Chinese racism and the BLM movement. Protests against racial injustice are not new, particularly not in the US, but have been exacerbated by the increased volume of death-related thoughts caused by the outbreak (Pyszczynski et al., 2020).

The fifth theme, "*sharing up-to-date information*", has been commonly observed during the pandemic. In a situation that causes high levels of uncertainty and feelings of vulnerability like the COVID-19 outbreak, people actively search for up-to-date information to fill the information gap and, thus, to make sense of the situation (Fischer-Preßler et al.,

2019; Maitlis & Christianson, 2014). This tendency is facilitated by the affordances of microblogging platforms, such as Twitter, which enable rapid information exchange among users. The unpredictability of the coronavirus due to the lack of complete knowledge on transmission and treatment motivates people to stay updated with the latest information (Abd-Alrazaq et al., 2020; Chandrasekaran et al., 2020).

The sixth theme, "*adjusting to the new normal*", involves peoples' attempts to adapt to the new way of life demanded by the COVID-19 pandemic. The impact of the outbreak on various aspects of life increases the need to adjust anxiety-buffering systems to the new environment (Pyszczynski et al., 2020). That is, people's efforts to adapt to changes in important aspects of their lives, such as education, business, and health, can help maintain their self-esteem during this uncertain time and thus restore major resources for managing death-related thoughts.

Finally, the seventh theme, *"psychological distress",* indicates responses from people whose anxiety-buffering systems malfunction due to the overwhelming amount of threatening information. Examples demonstrating psychological distress include stockpiling toilet paper and food staples (Chandrasekaran et al., 2020). This state is often exacerbated by heavy media coverage constantly reminding of death and vulnerability (Pyszczynski et al., 2020; Sowden et al., 2021).

2.4. Cultural differences of terror management

The second objective of this study is to examine differences in the adoption of defense strategies across three countries—the US, the UK, and India. Recent research on TMT has begun to examine the cross-cultural validity of terror management defenses by comparing the differences between individualist and collectivist cultures (Du et al., 2013; Kashima et al., 2004). Self-esteem serves as a buffer against mortality concerns based on the belief that one is a valuable contributor to the world (Pyszczynski et al., 1999). However, cultural differences in self-esteem derived from different aspects of the self-concept (i.e., personal and social self) (Markus & Kitayama, 1991) lead to different views of what constitutes a valuable person (Du et al., 2013). Self-esteem in individualist cultures is derived from perceptions of oneself based on personal attributes, such as competence, while self-esteem in collectivist cultures is defined in terms of one's ability to fulfill social roles and maintain harmony with others. These different modes of self-esteem are defined as independent and interdependent self-esteem, respectively (Markus & Kitayama, 1991; Oyserman et al., 2002). Therefore, cultural differences in the construal of self-esteem lead to different defense mechanisms in response to mortality salience. For example, Du et al. (2013) empirically showed that interdependent self-esteem serves anxiety-buffering functions more effectively in collectivist cultures (e.g., China) than independent self-esteem, which functions more effectively in individualist cultures (e.g., Austria).

Given the cultural differences between the three target countries of this study, the US, UK, and India (Kapoor et al., 2003), there are likely to be differences in defense strategies in response to death-related thoughts derived from the pandemic. Since people in individualist cultures such as the US and the UK rely on independent self-esteem as buffers against mortality concerns, more efforts will be put into restoring self-competence (Tafarodi & Swann, 1995). Ways to achieve this would be by adapting to the new normal in important across multiple aspects of life (Pyszczynski et al., 2020) or managing one's individual mental health (Vail, 2012). On the other hand, in collectivist cultures such as India (Kapoor et al., 2003), interdependent self-esteem serves better for anxiety management and thus defenses are expected to be related to interpersonal relationships (Du et al., 2013). For example, maintaining psychological connections with those who provide emotional support would be an important resource for managing death anxiety.

3. Methods

3.1. Social media site and datasets

The data for this study was retrieved from the popular social media platform, Twitter. Twitter is a free-to-use, micro-blogging social media platform that can instantly broadcast short messages to the world with few content and frequency restrictions. These short messages (up to 280-characters long) are called Tweets. We collected data by streaming publicly available tweets related to coronavirus using a Python library called *Tweepy* (Roesslein, 2009) from March 14, 2020 to Aug 18, 2020. This time frame corresponds to an approximately 5-month period, beginning when coronavirus was first declared an international emergency (March 11, 2020) (Cucinotta & Vanelli, 2020). To collect COVID-19 related tweets we used the following hashtags: #Coronavirus, #COVID19, #COVID. We collected a total of 13,440,664 (unique number of users: 4,447,667) tweets in English. We then further processed the user profiles of these tweets to extract user location according to their profile and identified tweets from India (num. of tweets: 180, 017; num. of users: 66,774), the UK (num. of tweets: 226,011; num. of users: 95,372), and the US (num. of tweets: 647,873; num. of users: 265, 283) to meet our research goal of investigating TMT-based defenses in three identified countries and further analyzing the cultural differences.

3.2. Topic modeling

We used a computational method called topic modeling to analyze our datasets due to the size of the dataset and range of topics discussed on Twitter. Similar computational methods have been used in the healthcare domain to extract information and analyze data (Friedman & Elhadad, 2014; Park et al., 2019; Park & Conway, 2017). First, we preprocessed the entire dataset to improve the modeling results. Less informative terms or tweets—specifically: URLs, HTML taggers within tweets, and tweets with less than 5 words—were removed from our analysis. Nouns were then extracted using the Python Natural Language Toolkit (NLTK) package (Bird, 2006) and integrated into our topic modeling, a set of document-level co-occurring words for a given set of documents, using Latent Dirichlet Allocation (LDA) (Blei et al., 2003) for each of the three countries. Due to the exploratory nature of this research, we elected to use LDA, an unsupervised algorithm, and considered each tweet as a single document. LDA requires a pre-determined number of topics. After experimenting with varying numbers of topics, we generated 15 topics each and employed most, if not all, of the identified topics to understand coronavirus-related issues from India, the UK, and the US. We used the Python package genism (Rehurek & Sojka, 2010), specifically 'LdaMulticore' with 7 cores, to conduct LDA analysis. To generated informative topic model, we experiment with a number of different filtering options. For our LDA model, we filtered out uninformative words that were either too common (i.e., appearing in more than 95% of total document) or too rare (i. e., less than 200 occurrences). To train the model, we set the random state to 100 after experimenting with different random seeds, made 20 passes during training with 100 training chunks (i.e., tweets), and set the minimum probability to zero to ensure tweets to have a topic. To control the prior distribution over topic weights in each document and word weights in each topic, we set the alpha and eta to 1e-5 and 5e-1. The main output of topic modeling includes a set of 15 topics generated from each location, in which each topic contains a subset of the high-frequency topic keywords. To better contextualize specific topics and enhance the interpretability of corresponding topic keywords, we extracted highest probability tweets for each specific topic.

The LDA results were further analyzed by two human coders (Chang et al., 2009) to label topics and to group the various topics into themes following procedures suggested by Debortoli et al. (2016). Two researchers identified a list of topic labels together and then independently labeled each topic using up to 30 most salient terms and up to 500 most

representative tweets. The initial inter-coder reliabilities of 0.80 for the US, 0.85 for the UK, and 0.87 for India were obtained for topic labels. Two researchers then independently grouped topics into appropriate themes; inter-coder reliabilities of 0.93 for the US, 0.92 for the UK, and 0.87 for India were observed. The research team discussed the remaining discrepancies until all conflicts regarding topic and theme labels were resolved.

3.3. User privacy

Analyzing publicly available data, such as social media data, is normally granted exemption from review by Institutional Review Boards. Nevertheless, ethical considerations, such as user privacy, still remain critical; thus, we removed any user identifiable information (e.g. usernames) and slightly modified user quotations (e.g. tweets), while retaining their overall messages, in the manuscript to protect user privacy.

4. Results

4.1. Terror management responses to the COVID-19 pandemic

The first research question of this study examines defense strategies that are commonly used to cope with mortality salience caused by COVID-19. A total of seven themes, drawn from the TMT framework, were consistently applied to three countries—the US, the UK, and India—to understand users' responses.

4.1.1. The US
Table 1 summarizes the 6 themes and 15 topics of COVID-19-related tweets observed among users in the US.

4.1.1.1. Searching for meaning.
The first theme, '*searching for meaning*', covers three topics: calls for prosocial behavior, meaning-of-life pursuits, and expressing gratitude. The first topic, 'calls for prosocial behavior', includes tweets such as donating to food banks to ensure people, especially children, have reliable access to food during the

Table 1
Themes, topics, keywords, and sample tweets related to the COVID-19 pandemic observed among users in the US.

Theme	Topic label	Keywords	Selected sample (modified) tweets
Searching for meaning	Calls for prosocial behavior	children, thank, times, help, family, need, people, leadership, leaders, food, members, issues, money, newyork, nygovcuomo, friend, lockdown, adults, time, group, needs, questions	Never too late to do your part! #covid19 still exist and many are still in need. Thank you Reverend [name] for giving PO. [name] deliver food to few people in need in NYC.
	Meaning-of-life pursuits	house, read, god, church, people, love, right, fear, cure, blood, role, job, family, cause, time, hell, white, black	My son has crippling fear because of his #autism. His sister taught him scripture to help. Stop letting your fear of #Coronavirus be bigger than your faith in God
	Expressing gratitude	support, teachers, students, doctors, nurses, lot, staff, families, challenges, act, line, service, course, director, experience, schools, start, studies, education, science	All hats off to the front line: the nurses, doctors, EMTs. I am also incredibly appreciative of those who make it possible for them to do what they do.
Political polarization and government incompetence	Political polarization	trump, realdonaldtrump, americans, gop, people, president, potus, trumpvirus, joebiden, vote, democrats, election, whitehouse, administration, thousands, republicans, maga, response, power, millions, biden, country, vp, failure	[name] is the most INCOMPETENT CORRUPT UNETHICAL RACIST LYING MISOGYNISTIC INEPT IMMORAL UNHINGED SELF-DEALING! GOP INCOMPETENCY IS KILLING AMERICANS! [number] SICK [number] DEAD
	Responding to stimulus packages	relief, recovery, people, congress, reason, senate, package, idea, stimulus, pandemic, use, senschumer, analysis, moment, result, money, speakerpelosi	Congress is still far apart on negotiations over the #COVID19 stimulus bill. It's time for [names] to get serious come to consensus before the Senate leaves for recess
	Responding to government's strategy	govrondesantis, florida, years, maskup, covidiots, man, news, citizens, issue, immunity, fight, breakingnews, report, stayhome, link, loss	[name], can you now realize that reopening this soon was a mistake?
Racial division	Racial hostility	people, virus, world, america, country, china, government, blacklivesmatter, control, things, pandemic, time, sign, flu, hope, fact, usa, question, shit, matter, war, lives	Leaked intel reveals how China deceived the world about coronavirus
Sharing up-to-date information	Up-to-date government guidance	state, county, watch, rt, california, update, travel, plan, order, governor, news, arizona, live, office, officials, cdc, medial, gov, residents, phase, plans, fuck, center	[name] provides update on #coronavirus in California. Watch here: [URL]
	Up-to-date information on virus	risk, death, video, article, daily, women, thanks, disease, people, hand, toll, transmission, cancer, water, ppl, changes, difference	Changes in risk factors. Pregnant women added, 65 older removed.
	Up-to-date statistics	case, deaths, day, data, number, today, tests, rate, people, county, state, week, death, florida, new, yesterday, testing, population, nation, hospital, georgia, report	[location] County COVID Numbers ([date]): Total Deaths: [number] Deaths reported today: Total Cases: [number] Cases reported today: [number] Mortality Rate: [number] Total Tests: [number]Tests reported today: [number]of pop tested: [number] New Case Metric: [number]
	Up-to-date information on treatments	vaccine, dr, pandemic, fauci, stay, youtube, interview, podcast, air, age, problem, people, truth, india, folks, development, episode, series	[number] treatments [number] vaccines in development for #COVID19. [name] is tracking the cures: [URL]
Adjusting to the new normal	Legal advice	law, justice, lawyer, thelegallowdown, lawfirm, legal, case, ip, tort, court, change, business, companies, technology, ai, cybersecurity, distancing, policy, mask, masks, face	[URL] COVID-19 Unpaid Overtime Claims
	Education	school, kids, students, symptoms, test, year, study, fall, person, parents, doctor, college, child, tips, results, hydroxchloroquine, ways, dr, friends, treatment, research, time	Everything You Need to Protect Yourself From COVID-19 with our own [name] in [name]
	Health	health, care, pandemic, workers, community, safety, crisis, response, healthcare, impact, communities, unemployment, access, today, emergency, resources, information, services, relief, patients, join, data, work, webinar, employees, learn, program, ppe	[name] is hosting webinar at [time] TODAY to discuss how virtual care tools can help support your patients and allocate resources properly during this crisis. Register here: [URL]
Psychological distress	Media chaos	news, media, story, thing, cnn, look, thread, quarantine, twitter, politics, share, msnbc, tweet, talk, level, foxnews, ass, force, jobs, example, word	The scariest thing is that don't know what to believe. The media has taken to whole other level and can't distinguish between real and whats not.

pandemic. This topic also revealed the need for a new form of leadership during these challenging times (e.g., *Leaders must adapt to the new normal.*). In the second topic 'meaning-of-life pursuits', users searched for meaning through their religious commitment (e.g., *Your heart may be heavy, but God's love heals all suffering. Amen*). The third topic, 'expressing gratitude', includes tweets that express gratitude for workers on the frontlines such as healthcare professionals and teachers (e.g., *Teachers are rising to meet unprecedented challenges during the #COVID19 pandemic. Now more than ever, we need to show our appreciation*).

4.1.1.2. Political polarization and government incompetence. For the second theme, '*political polarization and government incompetence*', three topics were identified: political polarization, responding to stimulus packages, and responding to government's strategy. The first topic, 'political polarization', deals with tweets demonstrating users' polarized responses to the Trump administration's handling of the COVID-19 outbreak. This polarization was further fueled by the US presidential election, which was upcoming at the time of data collection for this study (e.g., *It's time to vote the Liberal party out!*) (see also Allcott et al., 2020). The second topic, 'responding to stimulus packages', demonstrates public concerns about the late stimulus package due to White House officials and Democratic leaders' failure to reach a timely deal (Werner et al., 2020). In the third topic, 'responding to government's strategy', users blamed the Governor of Florida for a surge in coronavirus cases in Florida, as he did not roll back his reopening strategy because he did not believe it was a major contributor to the spike in cases (Reimann, 2020).

4.1.1.3. Racial division. The third theme, '*racial division*', includes a single topic 'racial hostility' wherein both hostility and calls for tolerance for racial injustice were found. In particular, hostility was directed against China, which users often referred to as COVID-19's country of origin (e.g., *Eventually, the Wuhan Coronavirus will be called a lab-created bioweapon*). Some users showed their support for the BLM movement and called for tolerance in response to racial hostility (e.g., I *hope on the other side of all what's happening, the world becomes a better place. #coronavirus #BlackLivesMattters #WeAreInThisTogether #GeorgeFloyd*).

In addition, a few tweets were found that contained multiple themes along with racial division. For example, some expressed *psychological distress* (i.e., the sixth theme from the US), maladaptive defenses, caused by racial division and violence (e.g., *The world is crazy now. It is bad enough with the #Coronavirus, but now we have pandemic of violence, protests and craziness! Where can I escape to?*).

4.1.1.4. Sharing up-to-date information. The fourth theme, '*sharing up-to-date information*', covers four topics: up-to-date government guidance, up-to-date information on virus, up-to-date statistics, and up-to-date information on treatments. The first topic, 'up-to-date government guidance', includes tweets regarding guidelines issued by individual states. The second topic, 'up-to-date information on virus', covers information on the transmission of the virus (e.g., *Asymptomatic transmission of #COVID19 is rare. #WHO*) and its risk factors. The third topic, 'up-to-date statistics', includes tweets sharing the latest updates on daily cases and death tolls. In the fourth topic, 'up-to-date information on treatments', users showed interest in the development of treatments and vaccines. In particular, in the fourth topic, among tweets regarding vaccine development, some responses showed destructive forms of proximal defenses, such as denying the existence of COVID-19 and viewing it as part of a conspiracy for profit (e.g., *Covid19 does not exist, therefore, how could there be vaccine? They will put something into your arm and whatever happens to you after, well that is your problem. #FakePandemic #coronascam*) (Kelland, 2021).

4.1.1.5. Adjusting to the new normal. The fifth theme, '*adjusting to the new normal*', covers tweets demonstrating users' attempts to adjust to

the new normal in regards to three aspects: legal advice, education, and health. In the first topic, 'legal advice', users discussed common legal issues arising from the pandemic such as unpaid wages. In the second topic, 'education', users shared health tips on how to survive on campus during the pandemic or alternative ways to pursue academic goals (e.g., *Personalized, competency-based schools had more successful transitions to remote learning*). The third topic, 'health', denotes tweets that shared links to webinars where experts discussed how to address the healthcare crisis (e.g., digital solutions). News regarding benefits for unemployed workers was also found (e.g., *Another 1.5 million filed for unemployment insurance*). In addition, many businesses exploited COVID-19-related hashtags and the pandemic environment to advertise products, especially digital solutions (e.g., *new #Business solution resources are available from* [Blank] *to help organizations combat #COVID19*).

4.1.1.6. Psychological distress. The sixth theme, '*psychological distress*', comprised the topic of 'media chaos', whereby users expressed psychological distress caused by a media environment saturated with fake news (e.g., *This proved to be Fake News. False story. Where's the media on this?*).

4.1.2. The UK
Table 2 summarizes the 6 themes and 13 topics of COVID-19-related tweets observed among users in the UK.

4.1.2.1. Calls for behavioral changes. The first theme concerns calls for behavioral changes to stop the spread of the virus and includes three topics: government response, encouraging downloads of the tracking app, and promoting social distancing. The first topic, 'government response', concerns the National Health Service (NHS)'s 'Test and Trace system' which is designed to track individuals with symptoms or at high risk of infection (NHS, 2020). Tweets regarding its guidance were shared (e.g., *If you have been close to someone with #coronavirus, here's how NHS Test and Trace will contact you #TestandTrace*). The second topic, 'encouraging downloads of the tracking app', promoted another tracking app developed by researchers from universities and hospitals in partnership with ZOE, a start-up in the healthcare sector, for non-profit purposes (Mayor, 2020). The third topic, 'promoting social distancing', includes tweets promoting social distancing initiated by individuals.

Furthermore, some tweets were found that contained multiple themes, such as *government incompetence* (i.e., the third theme from the UK) along with *calls for behavioral changes*. For example, users stressed the importance of using a non-government tracking app (e.g., *Just reminder: unlike the NHS app, this app is the one that actually works.*) and social distancing (e.g., *Pubs or schools Time to choose, you can't have both during #coronavirus, especially when you have corrupted and incompetent government.*) in response to government incompetence.

4.1.2.2. Searching for meaning. The second theme, '*searching for meaning*', includes a single topic 'managing mental health' wherein users shared tips on how to manage mental health (e.g., *ways to protect our mental health* […]) and offered motivational words to help people get through challenging times (e.g., *The pandemic provided us an opportunity to grow*).

4.1.2.3. Political polarization and government incompetence. In the third theme, '*political polarization and government incompetence*', users assigned blame to the government for its incompetent handling of the pandemic in four main areas: stimulus packages, government's strategy, healthcare system, and school operational strategy. The first topic, 'responding to stimulus packages', concerns financial aids provided by the government. For example, users voiced their frustration with the Self-Employment Income Support Scheme because it did not offer broad enough coverage to apply to them (Agyemang, 2020). Some questioned the need to continue with the UK's exit of the European Union,

Table 2
Themes, topics, keywords, and sample tweets related to the COVID-19 pandemic observed among users in the UK.

Theme	Topic label	Keywords	Selected sample (modified) tweets
Calls for behavioral changes	Government response	test, trace, symptoms, tips, contact, centre, twitter, office, today, day, article, things, communities, august, people, science, future, volunteers, time	NHS Test and Trace will mean anyone with symptoms will be tested and traced. If you have been close to someone with #coronavirus, here's how NHS Test and Trace will contact you #TestandTrace
	Encouraging downloads of the tracking app	cases, virus, app, spread, risk, download, symptoms, help, death, read, number, rate, report, challenges, figures, rt, results, share	Help slow the spread of #COVID19 and identify at risk cases by self-reporting your symptoms daily. Let's download the app
	Promoting social distancing	country, family, people, distancing, rules, measures, govt, uk, friends, minister, pubs, transmission, problem, decision, social, restaurants, government, reason, example	The BEST way to counteract #coronavirus is SOCIAL DISTANCING and we must all do it ASAP
Searching for meaning	Managing mental health	world, post, blog, health, mentalhealth, crisis, book, opportunity, piece, families, response, people, ways, charity, fight, situation, needs, time	Here's what I've written about how crisis be it mental health crisis or pandemic can be used as an opportunity to grow.
Political polarization and government incompetence	Responding to stimulus packages	business, borisjohnson, money, boris, johnson, rishisunak, fund, uk, brexit, time, questions, leaders, changes, government, tax, idea, situation	[name] is there anything you can do? have spoken to so many #selfemployed people who get nothing from [name]'s #COVID19 relief. More holes than Swiss cheese
	Responding to government's strategy	britain, borisjohnson, matthancock, crisis, work, response, guidelines, action, public, staff, health, industry, sector, rt, scheme, nhs, pay, people, rights	[name] scrapped Cabinet #pandemic team [number] months before #COVID19 hit #UK
	Responding to healthcare system	care, nhs, government, workers, ppe, health, uk, people, wave, homes, plan, bame, borisjohnson, handling, tories, inquiry, issue, emergency, campaign, president, millions, protection	[name] How many more healthcare workers will die before PPE gets the urgent attention? Which one of us will be next ?
	Responding to school operational strategy	children, school, community, june, concerns, education, quarantine, kids, parents, cummings, link, question, immunity, strategy, resources, page, teachers, insights	British government still plan on sending children back to school?! We are nothing but pawns to them, they do not care about the elderly, our children, or you.
Sharing up-do-date information	Latest news	pandemic, news, global, protests, alert, data, case, updates, live, trump, usa, latest, worldwide, america, bbc, video, watch, restrictions, rates, area, coronavirusupdates, scientists, place	Coronavirus Updates: Read The Latest News On The Pandemic [URL]
Adjusting to the new normal	Health	thanks, webinar, safety, face, great, health, join, share, podcast, event, series, daily, tomorrow, dr, experience, training, impact, coverings, online, youtube, register	Join us at the #COVID19 Webinar live currently talking Professor [name]
	Business/Economy	support, advice, business, company, help, information, economy, website, need, technology, employees, recession, guidance, team, people, government, service, group	[name] can help your business find the right support and information to lessen the impact of the #coronavirus outbreak
	New normal life	lockdown, new, life, london, uk, people, jobs, city, way, weekend, coronavirusuk, health, effect, football, time	As lockdown eases and reopen, we are thinking about the lasting impact of #covid19 on the way we work, shop and behave. Read our predictions
Psychological distress	Panic buying	people, covid19uk, infection, covidiots, shops, food, uk, sense, shop, places, disease, summer, hope, order, numbers, tory, management, government, level	UK shops are running out of toilet rolls, tinned goods, other non-perishable food. what weird bunch of people we are

commonly referred to as "Brexit", which would leave the UK more vulnerable to the economic recession caused by the pandemic (e.g., *UK government prioritized Brexit over Covid-19. Irresponsible*). The second topic, 'responding to government's strategy', demonstrates the growing perception of Johnson and his ministers' incompetence (e.g., *UK government #BorisTheButcher scrapped #pandemic team six months before #COVID19 hit in UK*). The third topic, 'responding to healthcare system', pointed out the unnecessary deaths of NHS healthcare workers and BAME (black, Asian, and minority ethnic) people (e.g., *The Government must investigate why BAME people are more likely to die from #COVID19 and come up with a plan to stop it.*) due to shortages of personal protective equipment (PPE), which they believed to be due to government corruption (e.g., *What to do with the corruption in this government regarding PPE contracts?*). The fourth topic, 'responding to school operational strategy', covers public concern about the government's school re-opening plan (Coughlan, 2020).

4.1.2.4. Sharing up-to-date information. The fourth theme, *'sharing up-to-date information'*, revealed a single topic 'latest news' wherein tweets sharing global news about the COVID-19 pandemic, including up-to-date statistics for the US, were found (e.g., [number] *new confirmed case(s) in USA totaling* [number]. [number] *worldwide*).

4.1.2.5. Adjusting to the new normal. The fifth theme comprises three main ways users attempted to adjust to the new normal: health, business/economy, and new normal life. The first topic, 'health', includes tweets that share links to webinars or podcast series about health issues

such as sleep disorders during the pandemic. The second topic, 'business/economy', covers users sharing guidance and resources to help businesses manage challenging times. The third topic, 'new normal life', concerns long-term changes associated with a post-COVID world. Tweets that exploited COVID-19-related hashtags to advertise new business opportunities were particularly common in this topic (e.g., *As lockdown eases and reopen, we are thinking about the lasting impact of #covid19 on the way we work, shop and behave. Read our predictions*).

4.1.2.6. Psychological distress. The sixth theme, *'psychological distress'*, includes a single topic 'panic buying' that revealed the extent of psychological distress people felt about those who engaged in panic buying, who were often called 'covidiots' (Mahdawi, 2020) (e.g., *Of course I am concerned about #covid19 but this stockpiling has got to stop! People who genuinely need them are not going to be able to get them #COVID19UK #COVIDIOTS*).

4.1.3. India
    Table 3 summarizes the 4 themes and 15 topics of COVID-19-related tweets observed among users in India.

4.1.3.1. Calls for behavioral changes. The first theme covers tweets calling for behavioral changes in response to COVID-19 that came from government and authority figures, which are represented in three topics depending on the source of information: government response 1, 2, and 3. The first topic, 'government response 1', includes guidelines shared by government bodies such as the Ministry of Information and Broadcasting

Table 3

Themes, topics, keywords, and sample tweets related to the COVID-19 pandemic observed among users in India.

Theme	Topic label	Keywords	Selected sample (modified) tweets
Calls for behavioral changes	Government response 1	pandemic, mask, mohfwindia, masks, way, pmoindia, times, risk, distancing, infection, drharshvardhan, contact, efforts, health, face, use, place, indiafightscorona, spread, mibindia	Maintain safe distance while shopping for essentials. Physical distancing prevents the spread of #COVID19. #TogetherAgainstCovid19
	Government response 2	staysafe, indiafightscorona, odisha, home, safety, stayhome, stay, details, measures, spread, list, hand, ganjam, drug, water, order, restrictions, precautions, steps, odishafightscorona, disease, visit, indiafightscoronavirus, coronaoutbreak	Stay indoors, exercise moderately, consume healthy diet, keep yourself engaged, wash hands
	Government response 3	modi, lockdown, pm, ji, india, fight, narendramodi, pmoindia, service, nation, bjp, president, rahulgandhi, shri, bjp4india, congress, minister, party, country	#India's fight against coronavirus is driven by people
Searching for meaning	Need for close relationships	people, family, friends, love, members, help, food, support, time, hope, money, pls, look, kids, issue, lot, matter, action, problems, shares, hunger	Being separated from family is stressful. Emotional support from family members is very important during pandemic.
Political polarization and government incompetence	Responding to school operational strategy	students, education, school, exams, children, year, sir, quarantine, drrpnishank, hrdministry, home, lives, state, pmoindia, govt, warriors, public	[name] Is the exam more important than the lives of students? We strongly condemn the guideline of the [name] Is the government putting students' lives at risk?
Sharing up-do-date information	Up-do-date statistics 1	covid19india, india, coronavirusindia, coronaviruspandemic, coronaupdate, lakh, stayhomestaysafe, coronavirusoutbreak, coronavirusupdates, app, covid19pandemic, coronaupdatesinindia, indiafightscorona, war, lakhs, coronaupdates, campaign	#CoronaVirusUpdates India [date] New cases Confirmed [number] Active [number] Recovered [number] Deaths [number]
	Up-do-date statistics 2	cases, deaths, india, today, number, state, death, hours, health, toll, reports, spike, total, odisha, update, recoveries, tamilnadu, coronavirusupdates, patients, district, indiafightscorona, department, maharashtra, day, karnataka	[location] [number] new #COVID19 positive cases, [number] recoveries Deaths reported in State in last 24 h, Now total number of cases in state Rises to [number] including [number] Recovered, [number] active cases [number] Deaths State Health Dept
	Up-do-date statistics 3	mumbai, data, new, case, maharashtra, result, latest, recovery, hospital, patients, cmomaharashtra, care, positive, centre, health, source, leader, covid19india, treatment, facility, bmc, active	#Covid19 Latest Updates [location] Positive: [number] Active: [number] Recovered: [number] Deceased: [number] New case: Data source: covid19india [date]
	Up-do-date statistics 4	india, positivity, fatality, rate, numbers, growth, chennai, days, increase, august, states, countries, june, week, month, population, containment, time, districts, weeks	The positivity rate of #COVID19 testing in [location] has risen to [number] over the past few days from less than [number] at the beginning of the month. Other districts, including [location and [location] also have more than [number] positivity rate
	Up-do-date statistics 5	test, samples, testing, kits, hospitals, icmr, treatment, technology, india, patients, research, results, medical, body, health, response, emergency, leadership, cost	[number] samples have been tested so far. [number] samples were tested yesterday, of which [number] samples were tested in [location] and remaining [number] samples were tested in [location]
	Up-do-date information on treatments	vaccine, development, phase, college, crisis, doctor, study, india, impact, world, market, months, pandemic, trials	[name] approves Phase II + III trials of [name] #COVID19 #vaccine in #India by [name]. Will hasten the development of #COVID19 #vaccine
	Latest news 1	district, kashmir, jammu, report, updates, city, jk, live, guidelines, july, community, area, issues, icmrdelhi, follow, till, persons, transmission, experts, administration, corporation, spread, today	The administration on Wednesday imposed [number]-day lockdown across the Valley, except [location], to contain the spread of the #coronavirus.
	Latest news 2	news, amitabhbachchan, bollywood, retweet, srbachchan, july, bachchan, daughter, share, media, blog, dailynews, vitorr, onlinenews, tweet, cricket	From [name] to [name]- Bollywood celebs who tested positive for #Coronavirus
	Latest news 3	world, virus, china, india, country, economy, rt, link, amitshah, pandemic, usa, brazil, battle, uk, indiafightscovid19, pakistan, outbreak, click	India is the third worst hit country by covid. so lets get stronger and more resilient and keep plowing ahead.
	Calls for blood donations	delhi, plasma, blood, need, type, number, state, kerala, hospital, twitter, telangana, hyderabad, gujarat, component, pradesh	[location] Need #Blood Type A-positive At [location]. Blood Component Need Plasma from A + ve #COVID19 recovered patient.

(@MIB_India) and the Ministry of Health & Family Welfare (@MoHF-W_INDIA). Guidelines issued by the state government (e.g., Odisha government) make up the second topic, 'government response 2'. The third topic, 'government response 3', is in regard to Prime Minister Modi's address to the nation which was given at the time of data collection of this study (Times of India, 2020). In particular, the importance of having a collective mindset was emphasized across all three topics (e.g., *#IndiaFightsCorona, #TogetherAgainstCovid19*).

Furthermore, the third topic includes some tweets containing multiple themes such as *political polarization* (i.e., the third theme from India) regarding the government's preventive measures, and most were against the opposition party (e.g., *It is used to be the Crime Hub of India. #Congress is party always makes political issues. Example They blame government for #coronavirus spread*).

4.1.3.2. Searching for meaning. In the second theme, *searching for*

meaning, a single topic, 'need for close relationships', was outlined, wherein users demonstrated their need for close relationships to manage challenging times. Tweets that called for prosocial behaviors were also shared (e.g., *The Slum Poor Children are Suffering from hunger in #Coronavirus Please* support *us to provide food and milk. The slum poor people and children #need your help for food and milk they are #suffering from hunger*).

4.1.3.3. Political polarization and government incompetence. The third theme contained a single topic, 'responding to school operational strategy', which indicated public concern regarding the government's nationwide decisions to hold final examinations despite the surge in coronavirus cases (e.g., *Is the government jeopardizing students'? #Cancel_Exam 2020*) (Shukla, 2020).

4.1.3.4. Sharing up-to-date information. The fourth theme, *sharing up-to-date information*, covers a total of ten topics, five of which were about up-

to-date statistics and three of which were about the latest news. The remaining two covered up-to-date information on treatments and calls for blood donations. The first five topics—up-to-date statistics 1, 2, 3, 4, and 5—largely concerned statistics for particular districts. The first topic, 'up-to-date statistics 1', covered tweets sharing nationwide updates on confirmed and recovered cases (e.g., *#CoronaVirusUpdates India* [date] *New cases Confirmed* [number] *Active* [number] *Recovered* [number] *Deaths* [number]). The second topic, 'up-to-date statistics 2', included state-level updates for states such as Karnataka, Odisha, and Tamil Nadu. The third topic, 'up-to-date statistics 3', was specifically about the state of Maharashtra where Dharavi, Asia's largest slum, is located. It became a major hotspot that attracted significant attention (e. g., *#COVID19 tally in Mumbai's #Dharavi slum rises to* [number] *with* [number] *new cases*) (Eeshanpriya, 2020). In 'up-to-date statistics 4', the positivity rates of testing in various districts including Chennai city were retweeted. In 'up-to-date statistics 5', information about sample testing was shared (e.g., [number] *samples have been tested so far*).

The topic 'up-to-date information on treatments' covers status updates on vaccine development. Information on stages of development and trials in both India (e.g., [blank] *conducts phase III trial of BCG vaccine for COVID-19*) and UK (e.g., *UK government says* [blank] *will begin human trials for coronavirus vaccine this week*) was shared.

Three topics concerning news updates were identified: latest news 1, 2, and 3. The topic 'latest news 1' covers tweets about Jammu and Kashmir, which have been the subject of disputes with Pakistan and were therefore vulnerable to the pandemic due to unprepared health-care systems (Wallen & Farmer, 2020). As part of 'latest news 2', entertainment news, including Bollywood news, was retweeted (e.g., *Bollywood celebs who tested positive for #Coronavirus*). 'Latest news 3' was about global news. Tweets that compared the positivity rate of India to other countries such as the US and Brazil were often shared. Furthermore, some tweets containing multiple themes were found, such as those that focused on racial division alongside global news. For example, some users showed hostility toward China, which they believed was the main contributor to the COVID-19 pandemic (e.g., *People dying. Economy tampered. Inflation rising. Bcz of Wuhan lab #ChineseVirus #ChinaLiesPeopleDie*).

Lastly, the topic 'calls for blood donations' included tweets sharing information about blood types in need of donations (e.g., [blank] *Need #Blood Type A-positive At* [blank]).

4.2. Cultural differences in terror management responses

The second research question of this study examines the differences in responses to the pandemic across the three countries. Table 4 summarizes the comparison of themes and topics. Differences were found in five out of seven themes—*political polarization and government incompetence, adjusting to the new normal, searching for meaning, calls for behavioral changes*, and *sharing up-to-date information*.

Major differences were found regarding *political polarization and government incompetence*. Users in the US and UK showed a tendency to assign blame to governments for their incompetent handling of the pandemic regarding, for example, economic issues, health, and education. On the other hand, no relevant topics were found among users in India. Rather, as illustrated above in the 'government response' topic in *calls for behavioral changes*, some tweets were found displaying political polarization but they did not warrant a topic of their own. This is due to the fact that most Indian users, unlike those from the US and UK, were against the opposition party and showed their support for the government by retweeting government messages. The only topic regarding government incompetence observed among Indian users was about their government's school operational strategy (i.e., the 'responding to school operational strategy' topic).

Topics related to *adjusting to the new normal* were found in the US and UK but not in India. For example, US users were active in searching for information in terms of legal issues, education, and health. In a similar

Table 4
Comparisons of themes and topics among the US, UK and India.

Theme	Topic label	US	UK	India
Calls for behavioral changes	Government response		✓	✓
	Encouraging downloads of the tracking app		✓	
	Promoting social distancing		✓	
Searching for meaning	Calls for prosocial behavior	✓		
	Meaning-of-life pursuits	✓		
	Expressing gratitude	✓		
	Need for close relationships			✓
	Managing mental health		✓	
Political polarization and government incompetence	Political polarization	✓		
	Responding to stimulus packages	✓	✓	
	Responding to government's strategy	✓	✓	
	Responding to healthcare system		✓	
	Responding to school operational strategy		✓	✓
Racial division	Racial hostility	✓		
Sharing up-do-date information	Up-do-date government guidance	✓		
	Up-do-date information on virus	✓		
	Up-do-date statistics	✓		✓
	Up-do-date information on treatments	✓		✓
	Latest news		✓	✓
	Calls for blood donations			✓
Adjusting to the new normal	Legal advice	✓		
	Education	✓		
	Health	✓	✓	
	Business/Economy		✓	
	New normal life		✓	
Psychological distress	Media chaos	✓		
	Panic buying		✓	

vein, UK users shared information in regards to health, business and the economy, and general predictions about the post-COVID-19 world. However, these topics were not observed among users from India.

Differences were also observed in the *searching for meaning* theme. Defenses observed among US and UK users involved the pursuit of meaning in life at the individual level, such as committing to religious beliefs (e.g., *My son has crippling fear because of his #autism. His sister taught him scripture to help. Stop letting your fear of #Coronavirus be bigger than your faith in God.*) (i.e., the 'meaning-of-life pursuits' topic from the US) and managing mental health (e.g., *The pandemic provided us an opportunity to grow*) (i.e., the 'managing mental health' topic from the UK). On the other hand, users in India showed a tendency to search for meaning through interpersonal relationships, as shown in the topic 'need for close relationships' (e.g., *Fear of being separated from family is stressful. Moral support from family members during this pandemic is very important*).

Regarding *calls for behavioral changes*, users in India were active in retweeting guidelines and preventive measures from government bodies with hashtags emphasizing collective responsibility (e.g., *#IndiaFightsCorona*) (i.e., the 'government response' topic from India), while such behaviors were not observed among users from the US and UK. As the UK has a publicly funded healthcare system (the NHS), tweets regarding the symptom tracking app developed by the NHS were shared (i.e., the 'government response' topic from the UK). Other than that, tweets that called for behavioral changes tend to be initiated by individuals (i.e., the 'promoting social distancing' and 'encouraging downloads of the tracking app' topic from the UK). In a similar vein, individuals from the US also voluntarily shared tweets calling for behavioral changes but such tweets were not enough to make up a distinct topic.

Regarding *sharing up-to-date information*, a distinct difference was found in the 'latest news' topic. While UK users shared global news based on up-to-date statistics (e.g., [number] *new confirmed case(s) in USA totaling* [number]. *Already* [number] *worldwide*), Indian users compared cases in India to those of other countries, typically followed by statements emphasizing collective responsibility for COVID-19 (e.g., *India is the third worst hit country by covid. so lets get stronger and more resilient and keep plowing ahead. #wearebrave #WeAreInThisTogether*).

5. Discussion and implications

5.1. Discussion

The primary purpose of this study is to examine people's responses to the COVID-19 pandemic and expand the current understanding of this issue, which has mostly been limited to health-related responses from infoveillance studies (e.g., Abd-Alrazaq et al., 2020; Boon-Itt et al., 2020; Xue et al., 2020). Considering the potential long-term impact of the COVID-19 pandemic, it is important to understand how people are coping with its challenges, which affect multiple aspects of our lives. Drawing on TMT as a theoretical framework, this study examined whether various reactions exhibited during the pandemic reflect defense strategies that are employed when death-related thoughts are salient. Consistent with previous research on TMT (Greenberg et al., 2000; Pyszczynski et al., 1999), this study found two types of defense strategies, proximal defenses and distal defenses, from tweets in the three target countries.

Themes related to proximal defenses included *calls for behavioral changes*. This theme was commonly observed in all three countries, most notably among UK and Indian users. The sharing of preventive measures, which were largely initiated by individuals in the UK and government organizations in India, serves to protect against conscious awareness of death and vulnerability (Goldenberg & Arndt, 2008; Pyszczynski et al., 2020). Such behavior was also observed among US users but was not enough to be a topic of their own. Additionally, US users in particular employed destructive forms of proximal defenses, such as viewing the novel virus as part of a conspiracy or scam. This trivializes the potential threat of the virus, thus pushing out their conscious awareness of vulnerability (Kelland, 2021; Pyszczynski et al., 2020).

Distal defenses were found in the form of worldview defenses, self-esteem striving, and the seeking of close relationships (Greenberg et al., 2000; Pyszczynski et al., 2020). Worldview defenses are reflected in the *political polarization and government incompetence* and *racial division* themes. Unlike Indian users, both US and UK users were active in sharing tweets demonstrating the government's incompetence in handling the COVID-19 pandemic in matters of the economy, health, and education. The need to defend one's worldview may lead to hostile attitudes toward governments due to a belief that incompetent handling of the pandemic threatened the user's way of life. UK individuals, in particular, promoted using a non-government tracking app as an alternative to the one developed by the NHS and actively retweeted social distancing messages, which were, in part, related to their worldview defenses facilitated by government incompetence.

Although the distinct topic 'racial hostility' in *racial division* was found only among US users, related tweets were also observed among UK and Indian users along with other themes. Specifically, hostility toward China was commonly observed, which may have been motivated by people's need to protect their in-group against an out-group (Das et al., 2009; Greenberg et al., 1990) that they believed to be a major contributor to the pandemic. Other distinctive responses depending on each country's social background were also found. For US users, many responses to the BLM movement were observed. Although the BLM movement seems to have no logical relationship with the COVID-19 pandemic, the need to defend one's worldview facilitated by the increased accessibility of death-related thoughts during the pandemic

could have intensified people's reactions to racial injustice (Pyszczynski et al., 2020). UK users called for tolerance for racial injustice and demonstrated concern about the higher vulnerability of ethnic minority groups (i.e., BAME) due to the lack of healthcare services and PPE, which they believed to be due to government incompetence.

Furthermore, there are other important topics from other themes that reflect worldview defenses. It is worth noting that people expressed gratitude to frontline workers (i.e., the 'expressing gratitude' topic in *searching for meaning*) and, at the same time, showed aggression toward those who stockpiled by calling them 'covidiots' (i.e., the 'panic buying' topic in *psychological distress*). This can be considered a form of worldview defenses, as previous studies demonstrate that mortality salience leads to more favorable evaluations of those who live up to the moral standards and hasher evaluations of moral transgressors (Florian & Mikulincer, 1997; Pyszczynski et al., 1999).

Themes related to self-esteem striving included *searching for meaning* as well as *sharing up-to-date information*. As self-esteem plays a vital role as an anxiety buffer (Harmon-Jones et al., 1997), users attempted to maintain it by engaging in behaviors that imbued their lives with a sense of meaning. Such attempts were commonly observed among the three countries in various forms, such as calling for prosocial behavior, searching for meaning through religious commitment, and managing one's mental health. Another way to strive for self-esteem is through staying updated with the latest information. Efforts to fill the information gap about the novel coronavirus and thus reduce feelings of uncertainty and vulnerability can help people maintain self-esteem to manage challenging times (Fischer-Preßler et al., 2019).

Distal defenses in the form of committing to close relationships were only demonstrated by Indian users. They considered maintaining psychological proximity with significant others as an important source of meaning in life that helped them feel secure during the pandemic (Mikulincer et al., 2003).

Given the reporting of ever-increasing case and death tolls alongside the enduring media coverage that constantly reminds viewers of death and vulnerability, people's anxiety-buffering systems were placed at serious risk of being undermined (Yetzer & Pyszczynski, 2019). Such undermining can result in either maladaptive defenses (i.e., *psychological distress*) or efforts to restore resources for managing death and vulnerability (i.e., *adjusting to the new normal*) (Pyszczynski et al., 2020). Both tendencies were demonstrated by US and UK users. While psychological distress was exacerbated by the spread of misinformation and social media content showing panic buying and racial division, people also attempted to adapt to the new normal by searching for information regarding important aspects of their lives.

The second objective of this study is to examine the cultural differences in responses to the pandemic. Cultural differences in both proximal and distal defenses were found. First, there were differences in proximal defenses regarding who initiated sharing information about preventive measures. Tweets that called for behavioral changes tended to be posted and shared by individuals in individualist cultures such as the US and UK, while such information was posted by the government in collectivist cultures such as India. This could be, in part, related to different perspectives on worldview defenses, which are elaborated on below.

Second, cultural differences in distal defenses were observed. We found that, consistent with previous studies conducted in laboratory settings (Du et al., 2013; Kashima et al., 2004), cultural differences in self-esteem that function as anxiety-buffers resulted in different responses to the pandemic. Since users in individualist cultures such as the US and UK cope with death-related thoughts based on independent self-esteem, efforts were directed at restoring one's self-competence (Du et al., 2013; Tafarodi & Swann, 1995). In that sense, US and UK users strived to adapt to the new normal in important aspects of their lives, such as education and business, so as to continue pursuing personal goals during this uncertain time (Pyszczynski et al., 2020) (i.e., *adjusting to the new normal*), and attempted to maintain self-esteem at the personal

level by managing their mental health (Vail et al., 2012) or committing to religious beliefs and practices (Vail et al., 2010) (i.e., *searching for meaning*). On the other hand, since interdependent self-esteem is a more pertinent buffer against mortality salience in collectivist cultures (Du et al., 2013), responses that showed the need for close relationships were more commonly found among users in India (i.e., *searching for meaning*).

A similar pattern of difference was found in themes associated with worldview defenses, particularly *political polarization and government incompetence*. People in individualist cultures are motivated to protect their self-competence against the government's incompetence, which they perceive as threatening their way of life, while those in collectivist cultures are based on interdependent self-esteem and thus tend to show support for their government which is an important part of their social identity (Feather, 1994). This was evident in the differences in sharing preventive measures, in that UK individuals stressed the importance of downloading non-government tracking apps and sharing social distancing messages in response to government incompetence while, in contrast, Indian users retweeted government messages with an emphasis on collective responsibility. A tendency for Indian users to encourage collective responsibility was also observed in the *sharing up-to-date information* theme. For example, while UK users shared worldwide statistics, Indian users compared such statistics with those of India and used them as motivators to encourage a collective mindset.

5.2. Theoretical implications

As COVID-19 has brought unprecedented crisis to the entire world, recent research has emerged to examine people's responses to the pandemic and the key issues that are often discussed in social media. Nevertheless, most research has been conducted from an infoveillance perspective, thus limiting our understanding to health-related responses, such as the origin of the novel coronavirus, preventive measures, and other public knowledge about the virus (Abd-Alrazaq et al., 2020; Boon-Itt et al., 2020; Chandrasekaran et al., 2020; Xue et al., 2020). Therefore, this study expands the current literature by suggesting TMT as a new approach and shedding light on people's responses as defense strategies against death-related thoughts brought on by COVID-19. By doing so, this study contributes to understanding not only what topics are discussed but also why they are discussed.

While there is a considerable body of literature on TMT, most empirical evidence is from laboratory settings (e.g., Greenberg et al., 1990; Harmon-Jones et al., 1997). Thus, a growing—albeit limited—body of research has emerged to examine the validity of TMT in real-life threatening situations, such as terrorist attacks, by conducting qualitative studies (Yum & Schenck-Hamlin, 2005) and analyzing social media data (Fischer-Preßler et al., 2019). This study contributes to this research stream by analyzing tweets from the midst of the COVID-19 pandemic based on the TMT framework.

One of the major research streams in TMT literature examines the cross-cultural validity of terror management defenses. While previous studies have documented the adoption of different defenses due to cultural differences in self-esteem, existing evidence is from laboratory settings (Du et al., 2013; Kashima et al., 2004). As such, this phenomenon requires further investigation under real-life circumstances. This research fills this gap by examining cultural differences between users in individualist cultures, such as those in the US and UK, and users in collectivist cultures, such as those in India (Kapoor et al., 2003). To the best of our knowledge, this study is the first to demonstrate cultural differences in TMT-based defenses based on real-life empirical data.

With increased availability and easier access to data through open APIs and other tools, recent Information Systems literature has witnessed a growth of data-driven research using methods from computer science, such as text mining (Kar & Dwivedi, 2020). However, as most data-driven research focuses on finding what is hidden behind the data, recent research calls for a connection with theoretical understanding to move towards "why it is so" (Kar & Dwivedi, 2020, p. 2). This study

contributes to this emerging research stream by understanding people's reactions based on TMT and providing empirical evidence to validate the existing theoretical framework.

5.3. Public health implications

Understanding the general public's reactions to a devastating pandemic, such as COVID-19, and explanations for those reactions can provide key insights for both public health practitioners and social media platform managers. First, public health practitioners should plan for effective messaging strategies, especially relates to the disseminator. Disseminating messages is critical in fostering shifts in social norms that are compliance with preventive measures and imbuing preventative behaviors with a sense of doing the 'right thing' (Courtney et al., 2020, p. 611). However, unlike collectivist cultures where the public tends to support government messages, government-initiated campaigns could backfire in individualist cultures due to the public's prevalent negative attitudes, as we can see from reactions to the UK and US governments' COVID-19 handling strategies. This does not mean that public health messages with prosocial appeals (vs. self-interest appeals) in individualist cultures would be ineffective, as recent studies show that such message framing is effective in individualist countries in encouraging preventative behaviors (Jordan et al., 2020). Therefore, effective health communications for individualist countries could benefit from coupling individual or non-profit organization-initiated campaigns with a prosocial emphasis.

Second, self-esteem of the public needs to be supported during health crises. Self-esteem is an important resource against anxiety and enables individuals to cope with difficult times by searching for meaning in life in their own way (Harmon-Jones et al., 1997; Pyszczynski et al., 2004). Therefore, it is important to develop interventions tailored to support the public in maintaining self-esteem, especially during a prolonged crisis like the COVID-19 pandemic. When developing such intervention programs, practitioners should tailor towards their public's cultural background. For example, interventions provided in individualist countries should be designed to support restoring one's self-competence, such as managing mental health and pursuing alternative ways to continue personal goals. Interventions in collectivist countries, on the other hand, should focus on helping the public find alternative ways to continue maintaining psychological bonds with family and friends.

Third, the findings of this study suggest the importance of creating supportive social media environments. Worldview defenses underlie publics' various responses to the pandemic, including negative responses, such as hostility toward those with different beliefs (Pyszczynski et al., 2020). In particular, racial hostility was frequently observed in both individualist and collectivist countries in this study. Constant exposure to threatening information can undermine people's ability to cope with death-related anxiety and lead to psychological distress. Thus, it is important to develop social media features that can constantly monitor and prohibit content advocating particular inter-group conflicts in order to enhance anxiety buffers of the general public during the pandemic.

Lastly, more effective public health efforts are needed for propagating credible information and countering misinformation. As COVID-19 is a novel virus, the public's anxiety is largely driven by feelings of uncertainty and unpredictability due to the lack of complete knowledge regarding its transmission and treatment. Thus, efforts to fill the information gap to reduce the feelings of vulnerability were commonly observed in both individualist and collectivist countries. However, a media environment rife with misinformation can mislead the public, encouraging people to make harmful decisions that ultimately cause psychological distress. Public health agencies can partner with social media platforms to educate the public about prevalent misconceptions and ensure they have access to credible health information (Raycraft, 2021). Furthermore, considering some social media sites are inundated with fake news, more effective government efforts are needed to urge

social media companies to regulate and filter out content advocating misinformation (Bose, 2021).

6. Limitations and future research

While offering new insights into people's responses to the COVID-19 pandemic from the perspective of TMT, this study has some limitations that necessitate future research. First, the current study was conducted based on responses from both individual users and government agencies. As governments use social media as a major communication tool to share preventive guidelines and boost morale among citizens (Rufai & Bunce, 2020), future research might narrow its scope to tweets generated by governments and examine whether there are characteristic differences in tweets across countries depending on their early success in curbing the spread of the coronavirus.

Second, we were not always able to determine appropriate topics for a group of key terms identified using LDA, due to an inability to coherently connect the terms. More specifically, we ended up with 13 topics for the UK, despite our computational model generating 15 topics. However, researchers can still use our results to understand which topics UK Twitter users most frequently discussed regarding COVID-19.

Third, the data may be subjective to self-selection bias, since not everyone uses Twitter. Similarly, young adults make up the biggest user demographic, although Twitter is more widely used by diverse user groups compared to other social media platforms (Perrin & Anderson, 2019). Thus, replicating a similar study with a different social media platform can bolster our understanding of TMT-based defense strategies as they relate to the pandemic and their associated cultural differences.

Fourth, although the dataset covers a 5-month period, which is a long enough timeframe to understand people's various defense strategies, dataset represents the early stage of the pandemic. During a prolonged pandemic, people adapt to the new way of life, which could lead to different topical discussions and defense strategies. Thus, future research should examine how salient topics and defense strategies change over time. In particular, given the emergence of Delta variant and vaccines, it would be worth exploring whether these changes lead to different defense strategies employed by people.

Credit author statement

Soyeon Kwon: Conceptualization, Validation, Formal analysis, Writing – original draft, Project administration. Albert Park: Conceptualization, Software, Formal analysis, Data curation, Writing – review & editing.

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