COVID-19 SPECIAL FORUM ARTICLE

Psychological Insights Into Information Processing During Times of Crisis

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The diffusion of accurate knowledge about diseases in the population is of critical concern to public health officials. This is because an informed public should be in a position to make better decisions, especially when these decisions impact other individuals, as is the case during pandemics. This article is aimed at presenting current research on the acquisition and propagation of medical knowledge in social networks under conditions of high perceived risk of viral infection. I will review recent psychological findings to show how anxiety associated with high perceived risk of infection could (a) negatively impact information processing, (b) activate motivational frames of processing, and (c) exacerbate the adoption of misinformation. Finally, I make specific recommendations for how to maximize accurate information dissemination and minimize the spread of misinformation.

General Audience Summary
Human societies constantly confront epidemics. To better prepare for these public health crises, it is important to understand how the human mind operates under conditions of risk and uncertainty. In this article, I review psychological research on how the anxiety that people experience during times of crisis negatively impacts what they pay attention to, what they communicate to others, and what they believe. I formulate a set of recommendations that policymakers and program planners could implement during epidemics to strengthen their communities' response.

Keywords: knowledge diffusion, misinformation, risk and uncertainty

With the rise of globalization, infectious diseases have proven more and more far-reaching (Saker et al., 2004). There is hardly a year without the emergence of a highly threatening pandemic, from H1N1 (swine flu) in 2009 to Ebola in 2014 to the Zika virus in 2017, and to COVID-19 in 2020. In this article, I argue that fighting epidemics involves not only developing medical treatments and ensuring wide distribution of these treatments but also efficient dissemination of information to the public. The main aim of this article is to provide insights about how knowledge should be transferred from medical labs to policymakers, program planners, and the lay public. I argue that a population that has scientifically accurate knowledge about a disease is one that is in a better position to make decisions aimed at mitigating the negative impact of epidemic spread. For instance, knowing that COVID-19 is spread by air droplets and only minimally by infected surfaces would result in protective behaviors that are aligned with this

belief: avoid poorly ventilated indoor areas versus constantly disinfect groceries.

To offer these insights, I acknowledge that these types of public health crises involve a high degree of uncertainty and risk perception that impacts both the adoption of information and its propagation through social networks. In what follows, I review how uncertainty and risk perception impact information adoption and propagation by (a) increasing anxiety, (b) activating motivational frames of processing, and (c) increasing the dissemination of inaccurate information. I will then address each one of these features and make prescriptions for how to diminish the negative impact of uncertainty and risk perception on the adoption of accurate information.

Although the adoption of knowledge has been studied in a variety of ways (Chirawattanakij & Ractham, 2015, Chou et al., 2015), very few models incorporate psychologically grounded assumptions about the acquisition and propagation of information under conditions of risk and uncertainty (Mayr et al., 2021; McCormack et al., 2013). Psychologists have long established that the context in which a person processes information meaningfully impacts what the person remembers, how she generalizes the knowledge, and how she subsequently applies it (Smith & Vela, 2001). First, most knowledge adoption models fail to account for the fact that information search, acquisition, and propagation often happen during public health emergencies, when the recipients of information are in a state of increased anxiety. Recent research shows that information processing might be drastically different under such circumstances

(Coman & Berry, 2015). Second, under conditions of high uncertainty, people's motivations impact what they are willing to accept as evidence for and against their beliefs. This dynamic, as extensive work in psychology has established, creates partisan divides in the knowledge that people come to acquire and share with one another. Studying how information propagates through social networks has the potential to reveal how to mitigate the fragmentation of knowledge during times of crisis. And third, and relatedly, conditions of risk and uncertainty are contexts in which misinformation thrives (Lewandowsky et al., 2012).

Finally, it is not sufficient to understand how public health crises create a context for biases in information processing. In order for this psychological research to be useful for public health officials and policymakers, research has to explore how to impact people's behavior in responsible ways in order to mitigate the spread of disease and, thereby, minimize casualties (Dovidio & Esses, 2007). Therefore, in addition to reviewing the relevant psychological literature on each of the three sections mentioned above (i.e., anxiety, motivation, and misinformation), I will also formulate recommendations on how these contextual factors should be taken into account to increase the adoption and spread of accurate information in societies during times of crisis.

Uncertainty and Risk Perception Enhance the Impact of Emotion on Information Processing

Public crises, such as a epidemics, create contexts in which emotion meaningfully impacts information processing. This is for at least two reasons. First, the information people are exposed to is emotional in nature. And second, the psychological state people find themselves in when processing information during these crises is of heightened anxiety and uncertainty. Any approach aimed at disseminating accurate knowledge in the population should, therefore, take into account these contextual features of the informational landscape.

The Stimulus Is Emotional During Public Crises

A large body of psychological research shows that information that is emotional in nature is preferentially processed by the cognitive system. This preferential processing entails enhanced attention (Carretié, 2014) and memory (Cahill et al., 1994) for the emotional information. Based on these well-established findings, we would expect that publicly available information that is emotional in nature to stick in the population and impact people's behaviors. The debilitating symptoms of COVID-19, the number of deaths in one's local area, and the struggles of hospitals to deal with critical cases likely registered with people around the world. There are reasons to believe, though, that this extreme focus on emotional information comes at a cost. Relevant information of a more practical nature could be crowded out by the focus on this emotional, less pragmatic, information.

This caution is anchored in a large literature in forensic psychology that shows that victims of violent crimes are more likely to remember peripheral pieces of information having to do with the gun they were threatened with, for instance, than the facial features of the perpetrator (Fawcett et al., 2013). Attention seems to be drawn to the most threatening environmental cues (Loftus et al., 1987).

A different line of research that supports a similar conclusion about the deleterious consequences of processing emotional information is studies on emotion-induced forgetting. These studies show that emotional stimuli lead to amnesia for neutral stimuli that either precede (retrograde) or follow (anterograde) the emotional stimuli (Hurlemann et al., 2005; Strange et al., 2010). This prominence of emotional information might be adaptive, effectively narrowing attention to cues that might be used to protect oneself in dangerous situations. But in the context of learning relevant information about an epidemic, this narrowing of attention will likely have negative consequences. Reading a newspaper article that begins with a very salient story about a family that was decimated by COVID-19 might draw one's attention to the topic, but might also distract them from deeply processing the section about best strategies to protect oneself from infection.

Recommendations. When it comes to exposure to emotional information, both traditional mass media (e.g., TV, newspapers) and more modern social media (e.g., Twitter, Facebook) seem to be incentivized to present and dwell on highly emotional information (Brady et al., 2020). As suggested, this might draw people's attention, but psychological research suggests that it might ultimately result in a less informed public. To counter this exaggerated attention on emotional features, the recommendation is for mass media actors to adjust their coverage and algorithms, respectively, in ways that capture people's attention (i.e., moderate emotion), but also provide reliable and simple information about the pragmatic behaviors people should engage in to mitigate the spread of the virus (Dai et al., 2015).

Both Facebook and Twitter have, in the past, implemented scientifically validated strategies to nudge their users to engage in responsible dissemination of information during times of crisis (Sharevski et al., 2022). They both added tags, for instance, to flag content with questionable accuracy. It would be relatively trivial to adjust their algorithm to amplify messages from individuals who have specialized expertise on the particular crisis a community is confronting at a given time (i.e., "verified experts" on Twitter). Such a preferential exposure strategy would likely impact the anxiety a community might experience and ensure a more scientifically accurate informational landscape.

Information Processing "Narrows" Under Conditions of Anxiety

In addition to the information being emotional, the psychological state of the recipients is also different during times of crisis, which leads to differential processing by the cognitive system (Rozin & Royzman, 2001). A prominent view about the adaptable nature of emotion proposes that emotion enhances memory for information that is salient for the person's currently activated goals (Levine & Edelstein, 2009). In other words, when people are in a state of anxiety, information processing narrows.

One might predict that during an epidemic people's goals are relatively clear: stay safe and avoid infection. But despite the fact that these simple goals are fairly straightforward, selecting relevant information from a highly complex informational landscape is a difficult task. This combination between clear goals and a complex informational landscape often results in suboptimal information processing. In a study aimed at understanding how anxiety about viral infections could lead to decreased information acquisition,

Coman & Berry (2015) focused on a typical occurrence during times of public crises. After acquiring disease-relevant information, people often listen to public figures (e.g., experts) discuss this information. What is the impact of listening to health experts selectively mentioning previously encoded information? Does the anxiety experienced by participants when they listen to experts impact their health-relevant knowledge?

Situations such as the one just described create the context for retrieval-induced forgetting (Anderson et al., 1994). That is, listening to experts mention health-relevant information might lead to the forgetting of unmentioned, but related information. Consistent with this phenomenon, Coman and Berry (2015) found that when people were exposed to experts who repeated information participants already knew, they were more likely to remember the information mentioned by the expert in a subsequent recall task. Importantly, relevant pieces of information that they knew initially, but was conceptually related to what the expert mentioned, was forgotten to a larger extent than unmentioned and unrelated information. It is important to note that participants who were in a condition that made them feel anxious about the possibility of contracting a disease forgot information related to what the expert mentioned to a larger extent than participants in a condition that did not experience increased anxiety.

These results showcase a paradoxical effect: Paying attention to an expert's message could result, under specific circumstances, in the forgetting of relevant information. More importantly, they point to strategies aimed at mitigating the impact of anxiety on knowledge acquisition.

Recommendations. It is clear that psychological calibration in the face of uncertain conditions is extremely difficult. But knowing how cognitive systems operate in these circumstances should reveal to policymakers adequate strategies aimed at disseminating information to the public. Based on these findings, communication of relevant information by experts should be performed in an exhaustive fashion, such that all relevant pieces of information are rehearsed and, therefore, strengthened. It is advisable that experts (e.g., Centers for Disease Control) rank the relevance and accuracy of the pieces of information they aim to disseminate to the public and consistently repeat the top-level ones across the different media they use to interact with the public (e.g., radio and TV interviews, Twitter, Facebook).

Another strategy to tackle the deleterious effects of the emotional state of the person who processes health-relevant information is to facilitate emotion regulation in the population. As discussed, pandemic circumstances expose people in high anxiety states to highly emotional information. These circumstances result in systematic biases in processing information. It is important, though, to clarify that there is variation in the population with respect to the degree to which people regulate their emotions during difficult circumstances. Appraisal theories of emotion propose that a person's evaluation of a situation impacts their emotional reaction (Levine & Edelstein, 2009; Scherer, 1999). A straightforward application of this theory to the current situation is that people who effectively regulate their anxiety should be able to avoid the narrowing of attention and deploy more complex behavioral repertoires to cope during times of crisis. Several emotion regulation techniques have been developed (Gross & Thompson, 2007; Ochsner et al., 2004) and implemented in the service of coping with both individual and public crises (Wang et al., 2021; Wilms et al., 2020).

Reappraisal techniques that involve the interpretation of the situation through a constructive lens (Troy et al., 2018), offering people plans to cope with limiting situations such as lockdowns (Polk et al., 2020), and helping them imagine a positive future (Dennis et al., 2020), have been found to downregulate negative emotions, manage stress more effectively, and, generally, result in increased psychological well-being during times of turmoil.

Uncertainty and Risk Perception Activate Motivational Frames of Processing, Increasing Societal Fragmentation

A burgeoning literature shows that political affiliation, and the internalization of a belief system that is an inherent component of political affiliation, dramatically impacts information processing (Smallpage et al., 2017). In the United States, allegiance to a political party is one of the most important predictors of COVID-19 anxiety, adoption of scientifically accurate medical knowledge, endorsement of conspiracy theories, and vaccination intention (Freiling et al., 2021). Even though more research is needed to explain these differences, several possibilities arise. Chief among them, threatening situations might make people more parochial, thereby activating people's motivations to belong to their ingroups and draw boundaries between their ingroup and other outgroups (Alizadeh et al., 2014; McDoom, 2012). Extensive research has established that people adopt and disseminate information from other ingroup members to a much larger extent than information from outgroup members (Coman & Hirst, 2015; Yamashiro & Hirst, 2020). In addition, a mass media environment in which people choose their sources of information to maximally match their preexisting beliefs further contributes to the fragmentation of societies. As do the structural features of people's social networks (both online and offline), which are characterized by high homophily (McPherson et al., 2001), and are also part of a system that reinforces people's preexisting beliefs (Brady et al., 2017).

Recommendations

In public emergencies politicians, pundits, and experts are often on the front lines of disseminating information to the public. They are, therefore, the main sources for the acquisition of knowledge in the population. The COVID-19 pandemic offered a unique situation to test their effectiveness in facilitating the acquisition of accurate medical knowledge. Vlasceanu and Coman (2022b) tested which sources of information were maximally effective at disseminating knowledge about COVID-19 to the population. In a census-matched sample of participants, they first measured the endorsement of a set of COVID-19 beliefs (e.g., "The sudden loss of smell or taste is a symptom of being infected with COVID-19") and then randomly assigned participants to information provided by one source of information. After this exposure, their COVID-19 beliefs were measured once again. Importantly, participants were randomly assigned to one of several sources of information from among: a generic group of participants, a democratic group of participants, a republican group of participants, an anecdote from a democrat, an anecdote from a republican, former President Trump, President Biden, Doctor Fauci, and the Centers for Disease Control. The results showed that information acquisition was significantly higher than in a control condition when it was promoted by a generic group

of participants, by normative cues (either republican group or democratic group), and by health experts. Notably, anecdotes and politicians were not effective at increasing knowledge, possibly because of the perceived bias of these sources.

It needs to be acknowledged that diminishing ideological differences is not easy to achieve, and it will likely involve a multidimensional approach. Leaders and elected officials could set the tone by communicating facts that underwent rigorous scientific investigation and scrutiny, societies could be better educated to accept scientific evidence and act accordingly, technology companies could restructure their platforms to diminish the factional nature of their audiences, and politicians could more frequently appeal to identities that are overarching and oriented toward cooperation, rather to the more narrow political identities that resonate with their most fervent supporters.

Uncertainty and Risk Perception Increase the Spread of Misinformation in Social Networks

Emotion not only impacts information processing at an individual level but also the propagation of information through communities. Research has showed that contexts high in emotionality result in high information propagation rates (Harber & Cohen, 2005), in the "viral" success of *New York Times* articles (Berger & Milkman, 2012), and in communicative advantages in dyadic interactions (Barrett & Nyhof, 2001). It is notable that during times of crisis, this enhanced propagation of information—be it from public sources or routine interactions among individuals—could easily backfire and result in the spread of inaccurate information. For instance, following the 2018 false alarm that a nuclear missile was headed toward Hawaii, this information persisted for days despite intense efforts to calm the population (Thompson et al., 2019).

Information disseminated through mass media by pundits, experts, and politicians is not simply passively received by the population. Rather, it further propagates through communities (Christakis & Fowler, 2009). It is, thus, critical, to understand the ways in which information propagates in people's interactions and how to create the circumstances for the efficient propagation of accurate information. At the most basic interaction level—the dyad—when a speaker repeats something already known to the speaker, by virtue of the repetition, the preexisting memory is reinforced and subsequently remembered better than it would be if it had not been repeated (Blumen & Rajaram, 2008). For the listener, the information mentioned by the speaker could be new or previously known. In both cases, the listener could benefit from learning new information or simply rehearsing known information. Critically, these dyadic-level influences (i.e., from speaker to listener) have been found to propagate in social networks (Coman et al., 2016). The propagation of these influences brings the focus on whether one's position in the network determines how influential one could be in impacting the knowledge that a community acquires. Research found, for instance, that temporally central individuals (i.e., those who are part of early conversations in the network) and those who are topologically central (i.e., highly connected individuals positioned at the center of the social network) have a larger impact on what the community remembers than more peripheral individuals (Geana et al., 2019).

These studies have been performed in contexts in which neither the information the participants studied, nor the contexts in which they studied and discussed this information, were emotional. In line with existing research, the high perceived risk of infection should accelerate the propagation of emotional information in social networks, giving additional weight to centrally positioned individuals to impact the knowledge communities end up acquiring (Drost-Lopez & Coman, 2018).

Situations that involve high risk and uncertainty create the perfect context for inaccurate information to spread, mainly because people lack the cognitive resources to assess the veracity of the information they receive (Wood et al., 2001). And the spread of misinformation is particularly nefarious since in public crises the consequences of endorsing misinformation are dramatic. Beliefs ranging from those that COVID-19 vaccines are unsafe to conspiracies that they are an effort by the government to implant electronic devices prevent people from vaccinating and will, no doubt, lead to unnecessary deaths. The pandemic shed light on the need for rigorous and efficient psychologically grounded interventions to diminish the spread of misinformation (Bavel et al., 2020). Several such strategies stand out.

Recommendations

Several psychological techniques have been developed and tested to diminish misinformation. One of the most well-established strategies aimed at targeting misinformation involves *debunking* (Lewandowsky et al., 2012). As part of this technique, people are presented with accurate information to counter the false information they endorse. While it's been found to be effective across a range of studies, new research shows that these attempts at debunking could result, in some contexts, in a backfire effect, such that targeted information experiences an increase in endorsement (Swire-Thompson et al., 2020). Follow-up studies suggest that debunking has the intended effect of diminishing misinformation, but it is often eliminated in high information contexts and its impact decays over time, likely because elites and the media continue to reinforce misinformation after debunking (Nyhan, 2021).

A recent study contrasted the timing of providing corrective messaging about false headlines (Brashier et al., 2021). The researchers compared corrective "tags" presented before, during, or after the participants read true and false headlines. At a 1-week follow-up, debunking (tags presented after exposure to misinformation) was found to outperform the two other strategies in increasing truth discernment. Of particular relevance, the study was conducted using a controlled experimental paradigm, which attempted to simulate a social media environment.

But prebunking—or providing warnings to people before they encounter misinformation—could have a meaningful impact, especially if it involves a more in-depth treatment (Roozenbeek et al., 2020). *Inoculation*, as a form of prebunking, involves both warning people they will encounter misinformation and exposing them to "low-dose" misinformation to practice discriminating between accurate and false information. A game designed to place people in the role of fake news creators tasked with designing misinformation content by using six common techniques was found to improve people's ability to resist misinformation (Roozenbeek & van der Linden, 2019).

Another simple technique to fight misinformation involves *accuracy nudges* (Pennycook et al., 2020). These nudges build on the fact that people share information unreflectively, which might

increase the dissemination of false information across social media platforms. To counter this dissemination, several studies simply asked participants to reflect on how accurate the headlines they are about to share are. This resulted in a decrease in sharing false headlines (Pennycook et al., 2020). The effect sizes for these types of interventions are fairly small, so additional research should clarify the specific conditions one could capitalize on to increase its efficiency (Roozenbeek et al., 2021; see also Vlasceanu and Coman (2022a), for a failure to observe an effect of epistemic accuracy on accurate knowledge acquisition).

There is also an emerging literature on the effect of *prediction errors* on belief update. These types of studies involve asking participants to make predictions about facts associated with their beliefs and then providing the correct answer. A recent study tested the effect of prediction errors on people's beliefs and discovered the effectiveness of this strategy, especially in circumstances that involve highly surprising information (Vlasceanu et al., 2021). Importantly, it appears that this strategy is effective irrespective of the political allegiance of the participants or the ideological nature of one's beliefs, suggesting that employing this strategy could be used in politically charged contexts as well to correct misinformation.

Finally, most of these strategies were developed and tested in environments that involve individuals processing information in isolation from one another. But, as previously suggested, in the real world, individuals find themselves in interaction with others, from experts, politicians, pundits, and newscasters to their family and friends. Vlasceanu et al. (2020), for instance, used network methodology to explore the impact of public speakers on people's beliefs. They found that the beliefs mentioned in the public speaker's discourse become more believable, and this believability was later amplified in people's repeated conversations compared to baseline beliefs. At the same time, beliefs related to those mentioned by the public speaker (but not mentioned themselves) decreased in believability, and this decrease persisted following conversational interactions in the network, relative to baseline beliefs. These effects held regardless of whether the beliefs were true or false, and over a 1-week period.

This survey of techniques aimed at fighting misinformation is by no means exhaustive (see Lewandowsky et al., 2012, for a more elaborate review). It does give a flavor of some simple to implement

strategies that have been (or are in the process of being) tested in the context of the COVID-19 pandemic. It seems that with an increased ability to collect data from large samples and across different cultures, a comprehensive test of these strategies would reveal the ones most efficient at diminishing misinformation and increasing the population's accurate knowledge. Ensuring measurement of belief persistence over time and testing the techniques in field studies that more closely resemble real-world environments should provide insights into the most effective psychologically grounded strategies to fight misinformation during future crises.

Concluding Remarks and Future Directions

COVID-19 has provided the context to investigate knowledge acquisition and dissemination in high-risk high uncertainty environments. It also challenged social scientists and policymakers to design efficient strategies to increase accurate knowledge acquisition and diffusion in communities and to implement strategies aimed at facilitating safeguarding behaviors (see Figure 1 for a schematic representation of how public crises impact information processing).

That said, there are several areas that would benefit from programmatic advances in an attempt to make psychological science more relevant during public crises. First, what became apparent during the COVID-19 pandemic is that despite the fact that people had access to accurate information about the disease, some chose to neglect it. They based their behaviors, instead, on false, inaccurate, and questionable information (e.g., "vaccines change DNA"). Research into how to nudge people into using accurate information when they have it at their disposal is certainly warranted. Promising avenues would likely involve first diagnosing and then changing the cognitive schemas that people hold to make the incoming information more palatable for adoption (Rumelhart, 1980). Moreover, acknowledging that the schemas have ideological and cultural dimensions will likely take us closer to successful strategies aimed at changing people's behaviors for their benefit (Wertsch, 2008).

Second, psychological scientists need to better calibrate their research questions and make them more applicable to real-world crises. Even though psychology was involved in extensive efforts to reduce the harmful consequences of the pandemic on the population

Figure 1

Schematic Representation of the Information Processing Characteristics of Individuals During Public Crises and Some Recommendations Based on These Characteristics
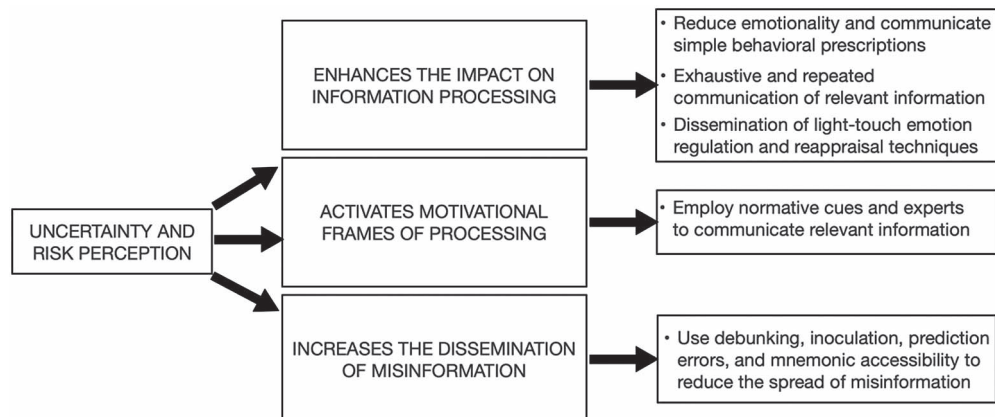
(Bavel et al., 2020), there are limitations to the prescriptions I was able to offer (IJzerman et al., 2020). Rigorous lab research should be complemented with real-world investigations if we want our science to be relevant for policymaking. An important proportion of psychological studies use fairly innocuous paradigms that are devoid of real-world relevance and which limit the impact one might have during times of public crises. For instance, whether people decide to vaccinate or not is, for a meaningful proportion of the population, tied into their core beliefs and, thus, deeply integrated in people's worldviews (Koltko-Rivera, 2004). Applying strategies derived from the investigation of trivial beliefs to these core beliefs is likely to backfire.

Third, most psychological investigations focus on understanding individual-level processes. From how people acquire information to how their beliefs impact their behavior, the focus is on individuals. But individuals are part of communities and policymakers are often confronted with population-level problems for which individual solutions are inadequate. For instance, for the spread of misinformation, strategies of targeting individuals for intervention would likely be less efficient than approaches that assume that individuals are interconnected as part of identity-charged communities. Thinking about inoculating populations with education campaigns that rely on communication among community members might be less time consuming, more cost-effective, and ultimately more efficient than strategies that assume that individuals act in isolation from one another. This thinking could lead, for instance, to developing models of misinformation spread that aim to create an informational herd immunity in the society and, by doing so, create communities immune to misinformation and conspiracy theory.

Finally, the way we as a society will remember this pandemic—and its lessons—will circumscribe how efficiently we will navigate the next one to come. Empirical investigations revealed that consequential events such as floods (Fanta et al., 2019) and World War II memories (Cordonnier et al., 2021) constitute prominent landmarks for the generation that experiences them, but fade dramatically for subsequent generations. Understanding how the collective memories of the COVID-19 pandemic form and decay over time could provide insights into how we as a society could preserve such memories for the benefit of our collective future.

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