



Distress and rumor exposure on social media during a campus lockdown

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During crisis events, people often seek out event-related information to stay informed of what is happening. However, when information from official channels is lacking or disseminated irregularly, people may be at risk for exposure to rumors that fill the information void. We studied information-seeking during a university lockdown following an active-shooter event. In study 1, students in the lockdown ($n = 3,890$) completed anonymous surveys 1 week later. Those who indicated receiving conflicting information about the lockdown reported greater acute stress [standardized regression coefficient (b) = 0.07; $SE = 0.01$; 95% confidence interval (CI), 0.04, 0.10]. Additionally, those who reported direct contact with close others via text message (or phone) and used Twitter for critical updates during the lockdown were exposed to more conflicting information. Higher acute stress was reported by heavy social media users who trusted social media for critical updates ($b = 0.06$, $SE = 0.01$; 95% CI, 0.03, 0.10). In study 2, we employed a big data approach to explore the time course of rumor transmission across 5 hours surrounding the lockdown within a subset of the university's Twitter followers. We also examined the patterning of distress in the hours during the lockdown as rumors about what was happening (e.g., presence of multiple shooters) spread among Twitter users. During periods without updates from official channels, rumors and distress increased. Results highlight the importance of releasing substantive updates at regular intervals during a crisis event and monitoring social media for rumors to mitigate rumor exposure and distress.

rumor | crisis event | Twitter | lockdown | social media

Since 2000, active shooter events in the United States have been on the rise and often result in higher casualty counts when they occur in educational institutions compared with other settings (1). Crisis events like these are often accompanied by deficits of credible information as authorities attempt to piece together the facts of the unfolding events. As a consequence, individuals caught in the wake of the crisis are left vulnerable to rumors and conflicting information from unofficial communication channels they trust. Despite a robust scientific literature on the circumstances in which rumors are generated (2–4) and transmitted (5, 6), little is known about the psychological correlates of exposure to rumors during crisis events. When rumors proliferate during dangerous and uncertain situations, what impact do they have on people who receive and believe them?

Crisis events are often ambiguous in nature, and when uncertainty is high, appraisals of threat among individuals caught in their path can be heightened (7). This, in turn, may instigate information-seeking behavior as a way of reducing situational uncertainty (8, 9) and consequently the psychological distress such uncertainty engenders (10). In the past, this information seeking led people to their radios and televisions to acquire critical updates from official channels. However, when a crisis unfolds, people now increasingly acquire critical updates from social media (e.g., Twitter; refs. 11–15), along with traditional media channels (16).

Moreover, when information from official channels is irregular or lacks new information, uncertainty and information-seeking behavior are likely sustained. As a result, people may also turn to unofficial channels, such as social media, to mitigate their

discomfort. The challenge with social media as a resource for updates, however, is the lack of mechanisms for vetting the accuracy of the information being shared among users. This is particularly important because, as the rumor literature suggests, trust in an information source moderates whether rumors are believed and transmitted (17). In addition, once rumors begin to spread on social media, they are very difficult to undermine with updates or corrections (6).

What people see when they are exposed to media-based coverage of a crisis event has been studied previously in the context of collective traumas, such as terrorist attacks and natural disasters that affect many people and occur without warning (16). Large studies of representative US samples demonstrate that, among other variables, repeated indirect, media-based exposure to collective traumas is associated with event-related distress, even when controlling for pretrauma media habits and preexisting mental health conditions (18, 19). For example, in a study following the Boston Marathon bombings (BMB), researchers found that 6 or more hours of BMB-related media use was associated with higher acute stress than was direct exposure to the bombings (18). This relationship is thought to be at least partly driven by the transmission of graphic, event-related imagery via news coverage (16, 20). However, when images are not relevant or available, other content, like rumors or conflicting information, may also contribute to the distress individuals experience during a crisis.

We explored the role of rumors in two studies of a single university shooting, using multiple methods to characterize the community's response. In study 1, we examined psychological

Significance

During active shooter events when danger is imminent and official information is disseminated inconsistently, ambiguity is high. In these situations, individuals may seek information from unofficial channels (e.g., social media), thereby exposing themselves to unverified information and rumors. In a study of students caught in a university-wide lockdown, we found that those who relied on social media for updates reported increased exposure to conflicting information. Moreover, those who trusted what they read reported greater distress. Then, using a big-data analysis of Twitter data spanning ~5 hours surrounding the event, we demonstrated that rumor transmission tracks with community-level negative emotion during gaps in official communication. Officials should monitor social media channels to mitigate the negative impact of rumors during collective traumas.

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Table 1. Correlates of acute stress among students in the lockdown

Variables	Model 1, <i>n</i> = 3,162 [†]			Model 2, <i>n</i> = 2,696 [†]		
	<i>b</i> (95% CI)	SE _{<i>b</i>}	<i>t</i>	<i>b</i> (95% CI)	SE _{<i>b</i>}	<i>t</i>
Completion week	-0.05(-0.08, -0.01)*	0.01	-3.10	-0.08(-0.13, -0.03)*	0.02	-3.23
Gender						
Female = 0	—	—	—	—	—	—
Male	-0.37(-0.44, -0.29)**	0.03	-10.27	-0.36(-0.44, -0.29)**	0.03	-9.30
Other	0.48(0.16, 0.80)*	0.16	2.98	0.44(0.08, 0.80)*	0.18	2.44
Age	-0.01(-0.05, 0.01)	0.01	-0.93	-0.001(-0.01, 0.01)	0.004	-0.32
Prior shooting exposure	0.17(0.08, 0.26)**	0.04	3.85	0.21(0.12, 0.31)**	0.04	4.48
Prior trauma—violence, war, other	0.13(0.10, 0.17)**	0.01	8.07	0.15(0.10, 0.19)**	0.02	7.09
Department affiliation, none = 0	0.10(0.03, 0.18)*	0.03	2.86	0.10(0.02, 0.18)*	0.04	2.53
Lockdown event exposure	0.09(0.05, 0.12)**	0.01	5.00	0.05(0.02, 0.07)**	0.01	4.00
Alone, with others = 0	-0.11(-0.21, -0.01)*	0.05	-2.25	-0.11(-0.22, -0.01)*	0.05	-2.14
Exposure to conflicting information	0.07(0.04, 0.10)**	0.01	4.28	0.08(0.04, 0.12)**	0.02	4.14
Count of traditional media use	0.01(-0.02, 0.05)	0.01	0.85	0.01(-0.03, 0.05)	0.02	0.40
Count of contact with friends/family	0.13(0.10, 0.17)**	0.01	7.21	0.09(0.06, 0.12)**	0.01	6.70
Count of social media use	0.07(0.03, 0.10)**	0.01	3.99	-0.15(-0.28, -0.03)*	0.06	-2.42
Social media trust	—	—	—	-0.06(-0.15, 0.01)	0.04	-1.55
Social Media Use × Social Media Trust	—	—	—	0.06(0.03, 0.10)**	0.01	3.66
Model statistics	<i>F</i> (13, 3,148) = 43.02, <i>P</i> < 0.001; <i>R</i> ² = 0.15			<i>F</i> (15, 2,680) = 33.31, <i>P</i> < 0.001, <i>R</i> ² = 0.15		

P* < 0.05; *P* < 0.001; all regression coefficients are standardized.

[†]Sample sizes vary across models due to missing data.

distress and correlates of communication-channel use among 3,890 students at a major university in the United States who were under a protracted lockdown (~2 hours) during an active shooter event in which critical updates from officials were infrequent. In study 2, we employed a big data approach to explore the time course of rumor transmission and patterning of distress during the lockdown.

Study 1

Data were collected using a Qualtrics survey software link emailed on the researchers’ behalf by the university administration to all enrolled students 7 days after the shooting. Students reported their distress about the lockdown by responding to items on a standardized multi-item measure of acute stress (21). Respondents also indicated the communication channels from which they acquired information and critical updates during the lockdown, including direct contact from close others (e.g., phone calls and texts from friends and/or family), traditional media (e.g., radio, television, online news), and social media (e.g., Twitter, Facebook, Snapchat, Reddit, Instagram). For every communication channel students used, they reported how much they trusted it for critical updates about the shooting and lockdown. To capture exposure to rumors during the lockdown, students reported the overall extent to which they received conflicting information about the details of the lockdown across all communication channels they used.

Results indicated that exposure to conflicting information was associated with acute stress related to the lockdown, after controlling for several relevant covariates (Table 1). Traditional media use was not associated with acute stress, but direct contact with close others and social media use were each associated with greater acute stress. We then examined whether trust in these communication channels moderated their respective relations with distress. No moderating effect was found for trust in direct contact with close others. However, greater acute stress was reported by heavy social media users who trusted social media for critical updates (Fig. 1). In addition, students who acquired critical updates via text messages from close others or via Twitter reported increased exposure to conflicting information compared to those who did not rely on these channels (Table 2).

Study 2

Because students in this first study who used Twitter reported increased exposure to conflicting information, in study 2 we examined the time course of community-level rumor generation and virality (i.e., degree to which rumors were circulated) among a subset of Twitter users who followed two official university Twitter accounts. Using R (22), we connected to Twitter via its Application Programming Interface (API) on the day of the lockdown and downloaded a list of the most recent 13,000 public followers of the university’s primary and emergency response Twitter accounts. Two weeks later, we downloaded the most recent 200 tweets from each follower. Because tweets were time-stamped, we constrained our analysis to tweets generated in the hour leading up to the initial 911 call until the second hour after the lockdown was lifted, segmenting time into 15-min blocks. Each tweet in this frame was tagged if it contained a rumor, defined as a statement verified to be blatantly false following the incident. To capture community-level distress about the lockdown, we devised an R script to automatically tag tweets referencing the lockdown

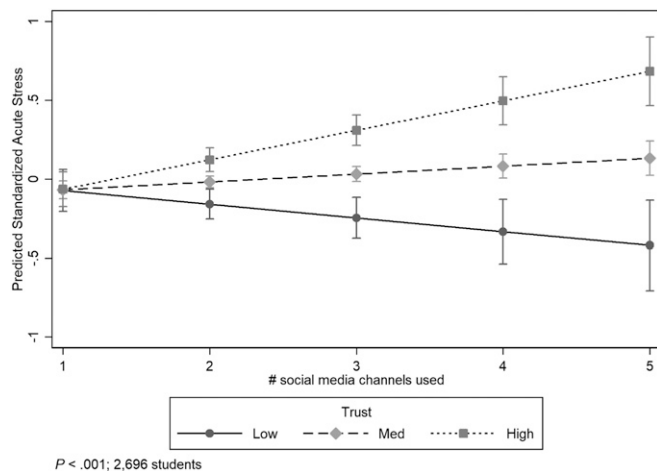


Fig. 1. Association between count of social media channels used during the lockdown and acute stress, moderated by level of trust in social media.

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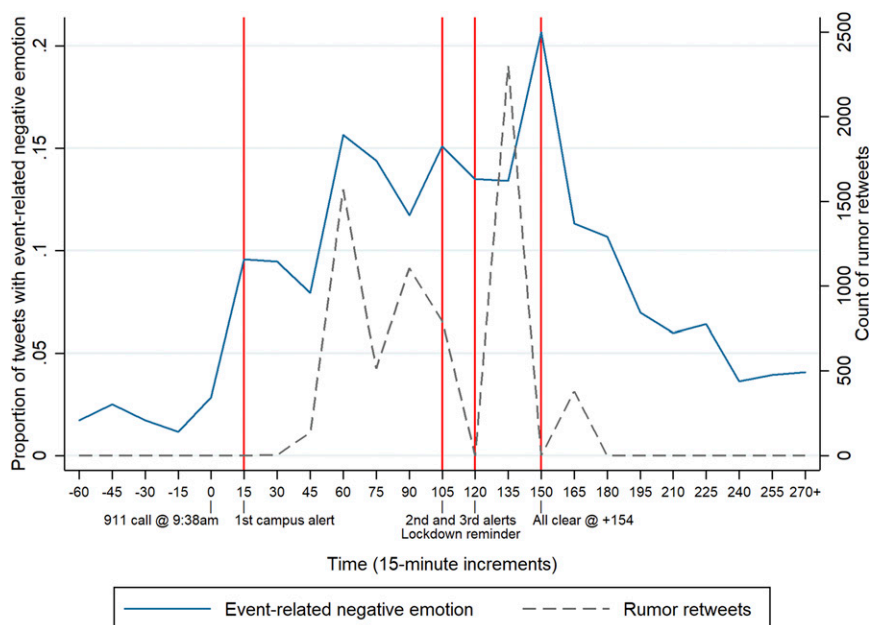


Fig. 3. Time course of rumor virality, event-related negative emotions, and campus alerts in the hours before, during, and after the lockdown.

channels would have mitigated rumors and distress using the data we collected, crisis communication scholars posit that regular communications from emergency management officials are essential for mitigating uncertainty and rumors after a crisis (30). For example, as part of their response to a mass shooting at a shopping mall in Munich, Germany, local police urged the public via press conferences and social media to resist speculation about the attack and directly addressed rumors on social media as they became aware of them (31). Despite false reports of additional shootings in the city and the overall lack of clarity about what was happening during the citywide lockdown, police chose to maintain transparency and constant contact with the public throughout the ordeal, a strategy likely appreciated by the public (32). Had the Munich police remained silent, however, the budding rumors about shootings in other city locations would have likely filled the information void. As communities learn to manage active shooter crises and other emergencies, crisis communications like those employed by the Munich police department will be prudent to put in place.

Second, critical updates disseminated to the public should include new information, when possible. However, when new information is not available, updates should be tailored to reduce situational uncertainty (33), thereby mitigating distress and rumors (30). Additionally, emergency management officials should attempt to counter the

impact of rumors that arise during crisis situations by monitoring social media channels and encouraging individuals to keep a healthy skepticism about information coming from unofficial channels.

Furthermore, we believe the news media, which play a critical role in informing the public during crisis events (30), must share the responsibility for disseminating accurate information. The importance of this point is illustrated by the examples of conspiracy theories propagated on social media (and other channels) that resonate with individuals psychologically attuned to alternative narratives (34). Although seemingly benign, conspiracy theories can lead people to deny that acts of horror, like the 9/11 terrorist attacks and the Sandy Hook Elementary School massacre, occurred at all. Consequently, denial narratives born from inconsistencies in news reporting can directly and negatively impact the individuals in communities devastated by these events (35).

Although we examined the correlates of unofficial communication-channel use in our analyses in study 1, we acknowledge the important role of official channel use during a crisis. Unfortunately, because 96% of respondents in our sample indicated consulting official channels, and roughly 92% indicated trusting these channels somewhat or strongly, the lack of variation precluded our ability to include these variables in our statistical models. Also, we are unable to determine whether participants actively sought—or

Table 3. Example rumors and their virality

Text of retweeted rumors	No. retweets
Description of perpetrator(s)	
[user omitted] per scanner [university name omitted] suspects are male and female white male approx 6 ft tall	103
[user omitted] [university name omitted] shooting 2 victims per [university name omitted] newsroom campus on lockdown shooter described as 6ft white male wearing black	859
[user omitted] police search for 6foot white male dressed in all black after two people shot dead at [university name omitted]	1,096
Warnings of multiple shooters and victims	
[user omitted] multiple shooters on campus right now make sure to get into a safe place	9
[user omitted] wtf multiple shooters people on stretchers 5 helicopters in the air im literally so scared right now	9
[user omitted] 2 confirmed victims down multiple shooters on the loose been almost 30 min still not caught	15

were passively exposed to—information from different channels. During the lockdown, participants may have sought information (especially during the 90-min gap in communication from campus officials) by accessing news sites and social media, or they might have sent text messages to friends and family to see if they knew any details. However, students could have simultaneously received unsolicited messages via social media or text during this event, in which case their receipt of information could be considered passive. An additional limitation of study 1 was that data collection occurred retrospectively (albeit soon after the event), and we did not employ real-time data collection methods during the lockdown (e.g., ecological momentary assessment), which would have been valuable for assessing exposure to conflicting information and distress responses. To compensate for this, we collected archival Twitter data—before, during, and after the lockdown—from thousands of users in study 2, providing supplemental data that occurred in real time. This supplemental analysis of Twitter data fostered additional depth to our understanding of the crisis event we studied.

Conclusion

Exposure to rumors and conflicting information that arise out of the ambiguity of a crisis may have negative consequences for the people who receive and believe them. Moreover, the extent to which people trust the channels through which unofficial and conflicting information flow may exacerbate distress. Rumor generation during ambiguous crisis events is certain to continue. Therefore, social scientists should study the psychological impact of rumor exposure using methodological triangulation to understand the dynamic contextual features of and community responses to these events. Doing so will help to better elucidate the function and impact of crisis-related communications, or the lack thereof, on distress responses. Science on crisis communications and the media can be an ally in this challenging set of tasks.

Materials and Methods

Study 1.

Sample and procedures. Beginning 7 days after the campus shooting, undergraduate and graduate students were invited to complete an anonymous, internet-based survey via a system-wide email sent on the researchers' behalf by the university administration. The survey was fielded to all 40,339 students listed in the university system. A reminder email was sent out a week later to bolster student participation. Participants who clicked the link to the survey were presented with an initial screen indicating that the purpose of the survey was to study the impact of the campus shooting; informed consent was obtained from all individuals included in the study. Participants were asked to complete the survey without consulting others and were instructed to answer items as honestly as possible. Participants were also presented with contact information for the lead researchers and the campus counseling center and encouraged to call or visit the center if they felt a need to speak with someone about their feelings regarding the incident. Data were collected up to 29 days following the shooting, with the majority of responses (92%) collected within 16 days post-event. The participation rate was ~18% ($n = 6,540$). Of these, 3,890 (~60%) students reported having been in the lockdown; between 2,696 and 3,393 of these students had complete information on variables across analyses in study 1. Of the 3,051 students who provided ethnicity data, nearly 40% identified as European American, roughly 30% identified as Asian American, and 14% identified as Latino American; the remainder identified as multiracial/ethnic (8.6%), African American (2.7%), or other (6%). All procedures for this study were approved by the Institutional Review Board of the University of California, Irvine.

Dependent variables.

Acute stress. Symptoms of acute stress were assessed using the Acute Stress Disorder Scale-5 (21), which is based on the *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition (DSM-5; ref. 36). Respondents used a 5-point Likert-type scale ranging from 0 (*not at all*) to 4 (*very much*) to describe the extent to which they experienced each of 14 possible reactions "since the shooting and lockdown" (e.g., "Do you have distressing dreams about the lockdown/shooting?"). Responses were summed (range, 0–56) to create a continuous score for acute stress symptoms and to capture maximum variability in potential responses (37).

Conflicting information. Respondents were asked to indicate the extent to which they agreed with the statement, "I received conflicting information from different sources about the details of the shooting." Responses were measured on a 5-point Likert-type scale ranging from 0 (*not at all*) to 4 (*a great deal*). Because no valid information about the event was available to any students during the lockdown, this variable was used as a proxy for rumor exposure.

To validate this assumption, we examined responses to an open-ended survey item that asked "What particular parts of the event were most upsetting to you?" We used an R script to code each response for whether it mentioned the word "rumor." Those who mentioned rumors reported higher exposure to conflicting information (standardized $b = 0.31$, $SE = 0.04$, $P < 0.001$). To further clarify what participants wrote about rumors, we examined the word pairs (i.e., bigram analysis) that occurred most commonly in the corpus of responses using a text analysis program called Meaning Extraction Helper (38). The four word pairs occurring most commonly were *multiple shooter*, *rumor spread*, *rumor multiple*, and *rumor shooter*. The words *rumors* and *false information* appeared in other responses with less frequency but were also present. Given that many respondents wrote at length, we also conducted a trigram analysis, which analyzes the most common occurrence of three words appearing together across responses. This analysis revealed that "rumor [of] multiple shooters" was the most common response.

Independent variables.

Traditional media and online news. On a 3-point Likert-type scale (0 = *not at all*, 1 = *some of the time*, 2 = *most or all of the time*), respondents indicated receiving critical updates from radio, television, and online news sites (e.g., CNN, *New York Times*, TMZ). Responses for each of these channels were dichotomously coded (0 = *not at all*, 1 = *at least some of the time*). They were aggregated to form a count of traditional media/online news sites used (range, 0–3).

Direct contact from close others. On a 3-point Likert-type scale (0 = *not at all*, 1 = *some of the time*, 2 = *most or all of the time*), respondents indicated whether they received critical updates from a group text message from a campus student organization, a text message from a friend, a text message from a family member, a phone call from a friend, and a phone call from a family member. Responses for each of these channels were dichotomously coded (0 = *not at all*, 1 = *at least some of the time*). They were aggregated to form a count of direct contact from close others (range, 0–5).

Social media. On a 3-point Likert-type scale (0 = *not at all*, 1 = *some of the time*, 2 = *most or all of the time*), respondents indicated whether they received critical updates from Twitter, Facebook, Snapchat, Reddit, and Instagram or some other platform not listed. Responses were dichotomously coded (0 = *not at all*, 1 = *at least some of the time*). They were aggregated to form a count of social media channels used (range, 0–5).

Channel trust. For each communication channel students reported using, they were asked to rate how much they trusted it for information about the shooting and lockdown. These ratings were reported on a 5-point Likert-type scale ranging from 1 (*strongly distrust*) to 5 (*strongly trust*). That is, if students reported using Twitter, they were asked to rate how much they trusted it for information and critical updates. Trust ratings were averaged across each communication channel category to create a composite of trust for traditional media and online news ($\alpha = 0.90$), direct contact from close others ($\alpha = 0.89$), and social media ($\alpha = 0.90$), respectively.

Relevant covariates.

Prior school shooting experience. Respondents indicated whether or not they, or someone close to them, ever experienced a school shooting. A total of 16.11% ($n = 611$) reported previously having such an experience.

Prior trauma exposure. Respondents were asked whether they personally experienced a natural disaster (e.g., tornado, earthquake), community violence (e.g., shooting, civil unrest), combat during war, or any other form of violence before the shooting. Responses across these four items were summed and ranged from 0–4.

Affiliation with affected department. To capture psychological proximity to the department where the shooting took place, respondents reported their affiliation with the department. In all, 26.2% ($n = 830$) indicated being affiliated with the department either by being a department major, minor, having taken classes in the department, or some other reason.

Lockdown event exposure. Respondents were asked to indicate whether they experienced each of 11 exposures to the lockdown (e.g., "I was in [building name omitted] when the shooting occurred"). Affirmative responses across these items were summed to create an index of event exposure. Responses ranged from 0 to 11 exposures.

Alone. Respondents indicated whether they were alone or with others during the lockdown. Responses were dummy coded such that if a student indicated being alone, he or she was coded with a 1.

Analytic strategy. Statistical analyses were conducted in Stata 14 (College Station, TX). A series of ordinary least-squares regression analyses were conducted to examine correlates of acute stress and exposure to conflicting information, respectively. Because a number of collective traumas were prominent in the media during data collection, we opted to control for survey completion week to account for the potential influence of these events on participant responses. We also included statistical controls for age and gender. Descriptive statistics for all model variables are reported in Tables S2 and S3.

Study 2.

Twitter user selection. There are several challenges associated with searching for tweets in a geographic area using the Twitter API. Although Twitter does

allow for searching based on geographic coordinates (geotags), only 1–5% of tweets are geotagged. Moreover, it is not currently possible to perform searches for tweets generated more than 3 days before the date of the search. To circumvent these challenges in the context of a campus shooting, researchers have relied on downloading tweets directly from followers of a university's Twitter account; the efficacy of this technique for approximating users who are likely to be students affiliated with the university has been demonstrated across several incidents of campus violence (23). Thus, on the day of the shooting and lockdown, we used the *twitterR* package (39) for R (22) to connect to the Twitter API and download the list of the most recent 20,000 followers of (or subscribers to) the university's main Twitter account and 6,000 followers of the university's emergency management Twitter account.

We then removed users from this list based on the following criteria: non-English language account, private account (in which case tweets would not be publicly available), "verified" account (usually indicative of high-profile Twitter users or businesses), and accounts with more than 1,000 total tweets (to omit superusers). After employing these exclusion criteria, 13,000 user accounts were available from which to pull tweets. Approximately 2 weeks after the shooting and lockdown, we interfaced with the API and requested the most recent 200 tweets from each user in our trimmed list.

Tweet processing. We downloaded nearly 2.3 million tweets. We then constrained our analysis to the time frame immediately around the lockdown: approximately 1 hour before the 911 call up until the end of the second hour after the all-clear. Within this 5-hour window of time, we captured 11,617 tweets from 2,863 users. After removing duplicate tweets, we were left with 7,824 tweets from 2,515 users.

Measures.

Rumor tweets. All tweets generated in the time frame around the lockdown were manually coded for rumors. A coder was instructed to tag tweets in the sample that contained information that was not verified at the time of the lockdown. Given that virtually no information was available during the lockdown, aside from official reminders that the university was on lockdown, the task of identifying rumor tweets was relatively straightforward. In all, 38 tweets with rumors were identified.

Rumor virality. Every tweet downloaded via the Twitter API comes with a measure of how many times it was retweeted. This measure captures the virality of the tweet over its lifetime and is not tied to its virality at a given

time point (e.g., during the lockdown). However, given the targeted nature of this event, virality was likely isolated to the lockdown as there would be no need to retweet any rumors about the lockdown after the all-clear.

Event-related negative emotion. We analyzed the linguistic content of each tweet using a custom R script that tallied the frequency with which words used in each tweet match words from the LIWC software's negative emotion dictionary (24). Similar to prior research (23), we also employed an R script that used a 17-item custom word list to automatically identify and tag tweets about the shooting and lockdown. This list included context-specific words (e.g., lockdown, #[university name]strong, #prayfor[university name]) to bolster the script's efficacy in identifying lockdown-related tweets. Tweets containing at least one negative emotion word and one word referencing the event were coded with a 1 (all others coded with 0).

Analytic strategy. Data were imported into Stata 14 (College Station, TX) from R (22), and tweets were combined into 15-min blocks across time. The proportion of tweets with event-related negative emotion expression in each 15-min block was calculated. We also calculated the quantity and virality (via retweet counts) of rumor tweets in each block, respectively. Event-related negative emotion expression was plotted across time, and rumor generation count and rumor virality were overlaid, respectively, in two graphs (Figs. 2 and 3).

Note: The university that allowed authors access to the students who served as subjects in study 1 did so with the proviso that the institution under study would not be revealed. Although data were collected anonymously, the identity of the institution and affected department are easily accessible in both the questions asked on the survey as well as in responses provided by subjects. Therefore, we are not allowed to release these data publicly. The affected institution is also clearly identifiable in the tweets analyzed in study 2. Although data cannot be posted publicly, we would be willing to make available to interested readers carefully redacted documentation and data files upon request.

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