Sadness Shifts to Anxiety Over Time and Distance From the National Tragedy in Newtown, Connecticut

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Abstract

How do increasing temporal and spatial distance affect the emotions people feel and express in response to tragic events? Standard views suggest that emotional intensity should decrease but are silent on changes in emotional quality. Using a large Twitter data set, we identified temporal and spatial patterns in use of emotional and cognitive words in tweets about the Sandy Hook Elementary School shooting. Although use of sadness words decreased with time and spatial distance, use of anxiety words showed the opposite pattern and was associated with concurrent increases in language reflecting causal thinking. In a follow-up experiment, we found that thinking about abstract causes (as opposed to concrete details) of this event similarly evoked decreased sadness but increased anxiety, which was associated with perceptions that a similar event might occur in the future. These data challenge current theories of emotional reactivity and identify time, space, and abstract causal thinking as factors that elicit categorical shifts in emotional responses to tragedy.

Keywords

In the wake of unthinkable tragedy, how do the passing of time and the spread of spatial distance affect the way individuals and society respond? Research addressing this question empirically stands to build understanding of how basic psychological mechanisms contribute to real-world patterns of experience and behavior, and has potential implications reaching from the feelings of individual people to policy decisions at the community and national levels.

Prior research and everyday intuition converge on the idea that people react with decreasing intensity to emotional events as their distance in time and space increases (e.g., Blanchard et al., 1997; Pennebaker & Harber, 1993). However, less is known about the psychological processes that bring about these overall decreases, or whether such processes might generate distinct patterns of change for particular categories of emotional response. This is especially surprising because different categories of negative emotion have distinct implications for how people think and behave. Sadness, for example, can engender constrained, repetitive thinking and sap motivation to act (Brinkmann & Gendolla, 2008; Carver & Scheier, 1998), whereas anxiety can prompt a vigilant cognitive style and spur actions that effectively manage or avoid potential threats (Maner, 2009; Oatley & Johnson-Laird, 1987).

We considered these issues in the context of responses to the shooting that occurred at Sandy Hook Elementary School, in Newtown, Connecticut, on December 14, 2012. This was one of the deadliest shootings in U.S. history, with 20 children and 6 adults murdered, and the traumatic impact of this event was felt across the country

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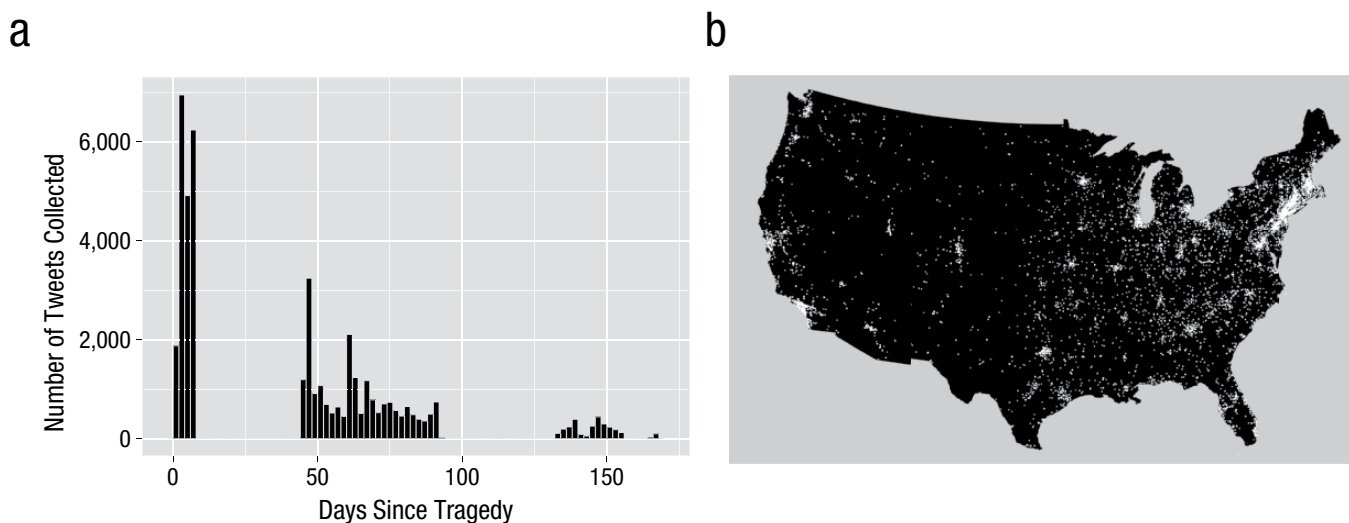E-mail: ochsner@psych.columbia.edu

Fig. 1. Distribution of the final sample of tweets containing the keywords "Newtown" or "Sandy Hook" across (a) time and (b) space. This sample excluded all instances of retweeted content, tweets in which less than 60% of the words were in the English dictionary, multiple tweets from a single user, tweets from different users that contained identical content, and tweets from users whose geographic location was not available in their profiles.

(Brown, 2012). Though trauma research has traditionally relied on field- or lab-based methods, modern Internet-based data sources provide unprecedented capacity for tracking responses to momentous events as they unfold, minimizing distortions and biases that emerge when people are prompted to recollect their past experiences (Levine, 1997). Using data-access protocols from Twitter, a social media platform used by hundreds of millions of people, we conducted a large-scale observational study that tracked responses to this tragedy across the continental United States over nearly 6 months.

With these data, we were able to test novel hypotheses about the nature of sadness and anxiety responses to tragedy. Extrapolating from prior work on emotion and psychological distance, we derived a *nonspecific distance hypothesis*, according to which sadness and anxiety would decay at a single rate. That is, if remoteness has direct effects on emotional intensity, it should affect different categories of negative emotion to a similar extent. Alternatively, according to a *construal-level hypothesis*, sadness and anxiety may diverge to the extent that they arise from appraisals differentially driven by concrete versus abstract mental representations of an emotion-eliciting event (Lazarus, 1991; Trope & Liberman, 2010).

According to construal-level theory (Rim, Hansen, & Trope, 2013), as people move away from a tragic event in time or space, their representation of that event should become less focused on its concrete features (e.g., what happened) and more focused on its abstract features (e.g., why it happened). From the view of appraisal theories of emotion (e.g., Lazarus, 1991; Scherer, Schorr, & Johnstone, 2001), this shift in representation should bring about a corresponding shift in emotional tone away from

forms of negative emotion evoked primarily by the low-level features of the tragedy (e.g., sadness in response to irrevocable loss) to those evoked more by high-level features of the tragedy (e.g., anxiety in response to uncertain future threat). We tested the competing nonspecific distance and construal-level hypotheses in an observational study of the aftermath of the Newtown shooting and then, in a follow-up study, considered the causal mechanisms underlying the observed emotional patterns by experimentally manipulating participants' construal of this tragedy.

Study 1: Using Twitter to Track Responses to the Newtown Shooting Over Time and Space

We gathered tweets (brief public messages posted to twitter.com) containing the keywords "Newtown" or "Sandy Hook" for nearly 6 months following the tragedy, sampling over three discrete time periods: December 14 through December 21, 2012; January 27 through March 3, 2013; and April 26 through May 30, 2013 (see Fig. 1a). Tweets were accessed via calls to the Twitter Streaming Application Programming Interface (API; Twitter, 2013). All study procedures were approved by the Columbia University Institutional Review Board.

Data cleaning

All tweets were downloaded in real time as they were published to the Streaming API (for details, see the Supplemental Material available online). Inspection of the resulting data set revealed that some of the tweets we had

sampled were duplicates, were spam, or had non-English content. We attempted to filter this content in order to focus our analyses on tweets with original, English-language content from individual users. We excluded all instances of retweeted content, tweets in which less than 60% of the words were in the English dictionary, multiple tweets from a single user, and tweets from different users that contained identical content (see the Supplemental Material for more details on these exclusions).

In order to estimate the proportion of tweets in the cleaned data set that were issued by personal rather than news media accounts, we had four raters code a random sample of 1,000 tweets as having been posted by an individual person or by a news media organization (an "unclear/other" option was also available), on the basis of the name of the account and the content of the tweet. Tweets were coded in groups of 200 at a time, and each tweet was coded by two raters. These judgments showed good levels of average absolute agreement (93%; Krippendorff's α = .66). They indicated that the majority of tweets in the cleaned data set had been posted by individuals (82%) and a minority had been posted by news media organizations (5%; see Table S1 in the Supplemental Material for further description of this sample of tweets).

Variables of interest

Predictor variables. Each message from Twitter was time-stamped, which allowed us to quantify temporal distance from the tragedy (in seconds). To quantify spatial distance, we constrained our analyses to users whose location field in their Twitter profile made it possible to locate them to a U.S. city or state (e.g., "New York City," "Arcata, California," "Colorado," or "Florida panhandle"). This left us with a data set of 43,548 tweets (see Fig. 1b for their geographic distribution). We used an open-source geocoding database to convert this location information to approximate latitude and longitude coordinates (OpenStreetMap Contributors, 2013) and conducted subsequent manual checks to flag and correct or remove geocoding errors and ambiguities (see the Supplemental Material). To validate these geocoded coordinates, we compared them against captured GPS location data, which were available for approximately 0.6% of our sample, and found that the two types of location data agreed within 200 miles for 92% of tweets with both types of data available. Finally, for each tweet, we calculated the geometric distance from Sandy Hook, Connecticut, using the Haversine formula (Sinnott, 1984). We used this measure in our analyses of spatial distance.

Outcome variables. We derived several outcome variables of psychological relevance on a tweet-by-tweet

basis. For an index of the societal-level expression of thoughts related to this tragedy across time and space, we estimated tragedy-related tweet volume for each tweet in our data set. Specifically, we determined the per-second rate of publication of tragedy-related tweets at the moment the tweet was published. We refer to this variable as the *tweet-per-second rate*. We next quantified the emotional and cognitive content of the tweets using Linguistic Inquiry and Word Count (LIWC), a prominent lexicon and software package that computes frequencies of words reflective of particular psychological states (Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007). The LIWC dictionary includes multiple word categories that have been validated against human judgments of texts' psychological content. We focused on three broad classes of content. First, we considered present-tense verbs and first-person pronouns, which indicate attention to one's self and one's present temporal context and thus reflect a sense of psychological immediacy (Tausczik & Pennebaker, 2010). Second, we considered affect words, which are reflective of experience and expression of emotional states in general (Kahn, Tobin, Massey, & Anderson, 2007), as well as sadness words, anxiety words, and anger words, categories that reflect particular kinds of negative emotion (Tausczik & Pennebaker, 2010; Tov, Ng, Lin, & Qiu, 2013). Third, we looked at words that reflect attention to causal processes, which in the context of traumatic events are known to mark a relatively complex and abstract style of thought focused on creating causal explanations (Boals & Klein, 2005; Tausczik & Pennebaker, 2010).

Analyses

We used regression models to quantify independent effects of time (rescaled for interpretation as number of months) and approximate distance (rescaled for interpretation as thousands of miles) on tweet features; rescalings were conducted via multiplication by a conversion factor. We simultaneously included covariates of no interest to model effects of total tweet word count, county-level population density (U.S. Census Bureau, 2013), local politics (i.e., percentage of the popular vote Mitt Romney received in the 2012 presidential election, at county and state levels; Rogers & Cage, 2013), and linear, quadratic, and cubic effects of time of day. These covariates allowed us to statistically account for potential third variables that may have obscured or driven relationships between remoteness and use of particular word categories. For example, the total-word-count covariate allowed us to account for the possibility that time and spatial distance led to changes in the overall number of words used. The local-politics and population-density covariates allowed us to account for the possibility that social and political

qualities of Twitter users' local environments were related to distance from Newtown and also predictive of word use. The time-of-day covariates allowed us to account for circadian changes in word use.

We tested exponential decay of tragedy-related tweet volume by taking the natural log transform of the tweets-per-second index and entering this transformed variable into an ordinary least squares model. Because the raw LIWC word-count variables followed overdispersed count distributions (i.e., with variance greater than the mean), we fit these data with negative binomial regression models (see Hilbe, 2011).

Results

Average word counts. To characterize the affective content of the tweets in our data set, we computed word-count averages for the LIWC emotion categories, collapsing across time and distance. On average, the tweets in our data set had a total of 14.89 words ($SE = 0.03$) and 0.97 affect words ($SE = 0.005$). Within specific negative-emotion categories, the mean number of words was 0.16 for sadness words ($SE = 0.002$), 0.05 for anxiety words ($SE = 0.001$), and 0.26 for anger words ($SE = 0.003$).

Effects on expression, immediacy, and overall affect. As predicted by both the nonspecific distance hypothesis (which posits that remoteness has general effects on emotion) and the construal-level hypothesis (which posits that remoteness leads to more abstract forms of representation), we found that the passage of time led to an exponential decrease in tweet-per-second rate, $b = -1.27$, 95% confidence interval (CI) = [-1.28, -1.26], $p < .001$, and linear decreases in number of first-person pronouns, $b = -0.062$, 95% CI = [-0.082, -0.043], $p < .001$; present-tense verbs, $b = -0.069$, 95% CI = [-0.079, -0.059], $p < .001$; and affect words overall, $b = -0.073$, 95% CI = [-0.082, -0.064], $p < .001$. Increasing spatial distance brought about an independent and corresponding pattern, evoking an exponential decrease in the tweet-per-second rate, $b = -0.040$, 95% CI = [-0.056, -0.022], $p < .001$, as well as linear decreases in use of first-person pronouns, $b = -0.049$, 95% CI = [-0.081, -0.017], $p < .005$; present-tense verbs, $b = -0.022$, 95% CI = [-0.038, -0.006], $p < .01$; and affect words overall, $b = -0.033$, 95% CI = [-0.047, -0.020], $p < .001$. In summary, we observed time- and distance-related changes in word use suggesting decreases in posting of tragedy-related content, expression of psychological immediacy, and expression of emotion.

Effects on sadness, anxiety, and causal thought. Next, we considered changes in use of sadness, anxiety, and causality words, for which the construal-level hypothesis makes unique predictions. As predicted by this hypothesis, increasing time led to a decrease in use of sadness words, $b = -0.377$, 95% CI = [-0.405, -0.349], $p < .001$; an increase in use of anxiety words, $b = 0.116$, 95% CI = [0.079, 0.152], $p < .001$; and an increase in use of causality words, $b = 0.021$, 95% CI = [0.004, 0.038], $p < .05$ (see the graphs in Fig. 2). Similarly, increasing spatial distance brought about a decrease in use of sadness words, $b = -0.057$, 95% CI = [-0.091, -0.022], $p < .001$, and increases in use of anxiety words, $b = 0.105$, 95% CI = [0.044, 0.166], $p < .001$, and causality words, $b = 0.050$, 95% CI = [0.023, 0.077], $p < .001$. Follow-up analyses suggested that temporal patterns in word use were still evident when analyses were limited to sampling waves of equal duration (see the Supplemental Material).

Moreover, a path model (with time and distance as predictors, number of causality words as a mediator, number of anxiety words as the outcome, and total tweet word count as a covariate) revealed that the increase in use of anxiety words with increasing time and spatial distance was partially mediated by an associated increase in use of causality words, indirect effect of time = 0.006, 95% CI = [0.003, 0.009], $p < .001$; indirect effect of spatial distance = 0.005, 95% CI = [0.000, 0.009], $p < .05$. An analogous path model with use of sadness words as the outcome indicated that number of causality words did not significantly mediate either the effect of time on use of sadness words, indirect effect = -0.0006, 95% CI = [-0.002, 0.0004], $p = .24$, or the effect of spatial distance on use of sadness words, indirect effect = -0.002, 95% CI = [-0.004, 0.001], $p = .23$. These two path models were implemented via the gsem (generalized structural equation modeling) command in Stata 13, with family set to "negative binomial." Significance of indirect paths was assessed with the nlcom command (which computes delta-method standard errors; StataCorp, 2013).

Effects on anger. For comparison purposes, we also investigated effects of time and spatial distance on anger, an emotion previously identified as a key component of the societal-level reaction to violent tragedy (e.g., Lerner, Gonzalez, Small, & Fischhoff, 2003). We found that use of anger words did not change significantly across time, $b = -0.01$, 95% CI = [-0.03, 0.01], $p = .37$, but did increase significantly with increasing spatial distance, $b = 0.10$, 95% CI = [0.07, 0.13], $p < .001$. (For additional information about the magnitude of the effects of time and spatial distance, see Tables S2 and S3 in the Supplemental Material.)

Mapping patterns of use of sadness, anxiety, and causality words. To more thoroughly model and visualize patterns of word use across space, we ran a series of three-dimensional spatial regression models. In each model, a smooth surface was fitted to the observed data
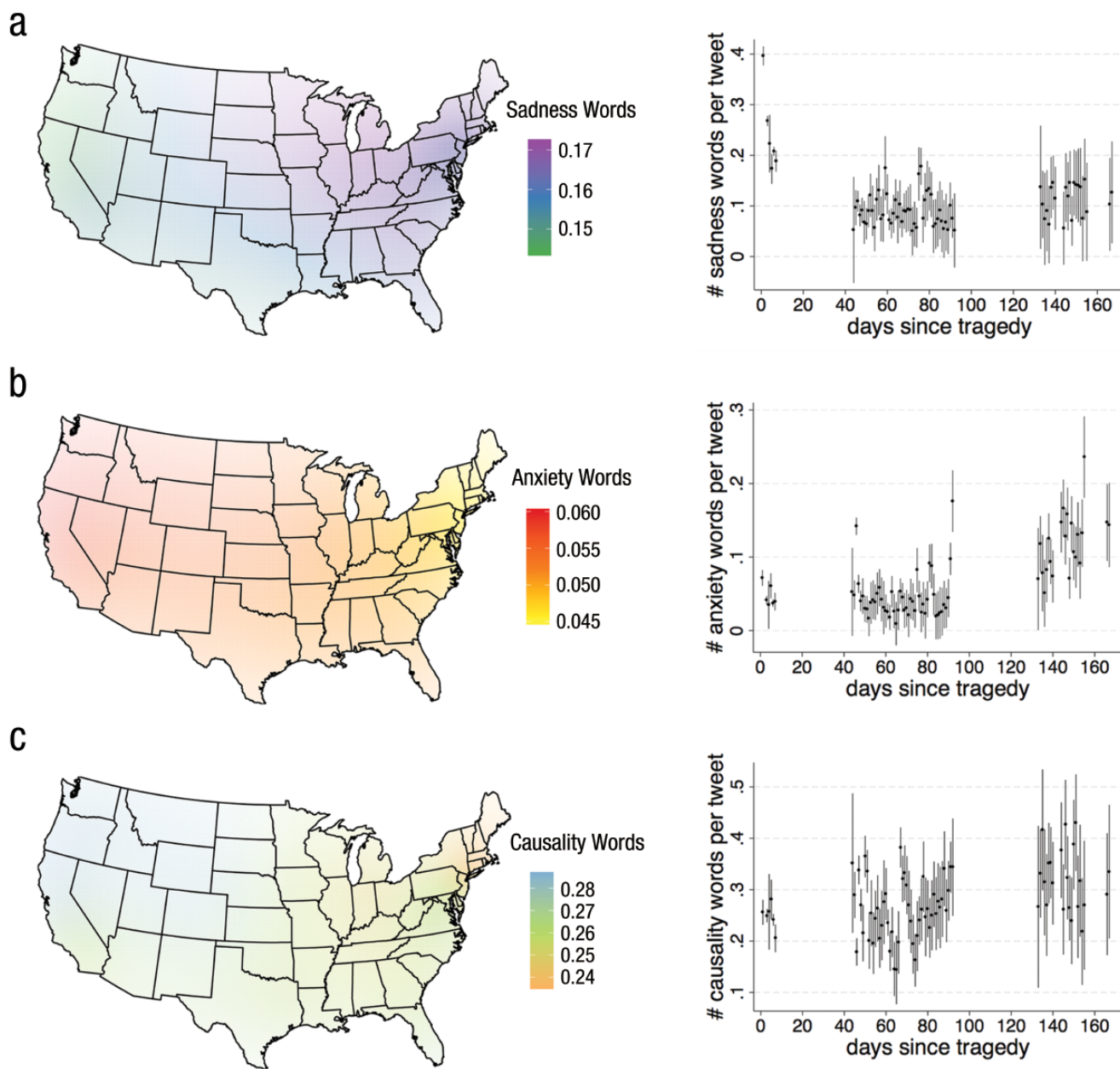
Fig. 2. Results from Study 1: mean number of (a) sadness, (b) anxiety, and (c) causality words per tweet in tweets collected during the three sampling periods between December 14, 2012, and May 30, 2013. Effects of spatial distance are illustrated in the maps, which were derived from a series of three-dimensional spatial regression models; mean frequencies are indicated by color (and greater precision of the model's predictions is represented by greater opacity). Effects of temporal distance are illustrated in the graphs, in which mean frequencies are plotted as a function of time since the Newtown shooting (aggregated in 24-hr bins); error bars represent 95% confidence intervals.

to predict a tweet feature (y) across the continental United States as a function of latitude (x_1) and longitude (x_2). To define these surfaces, we implemented a penalized thin-plate regression spline method using the *bam* function within the mgcv package in R (Wood, 2003). The mapped surfaces (see Fig. 2) represent levels of word use with variations in color and model precision (i.e., the inverse of prediction standard error, determined in part by data density) with variations in opacity. As

expected, these mapped models are consistent with the linear regression analyses reported earlier (which collapsed latitude and longitude into a single distance dimension), but they provide more information about the spatial patterns of change in use of sadness, anxiety, and causality words.

Word-level analyses. To characterize the nature of these relationships at the level of individual words, we

Table 1. Individual Sadness, Anxiety, and Causality Words Most Strongly Associated With Increasing Time and Spatial Distance From the Newtown Tragedy

Greatest change over time			Greatest change over spatial distance		
Word	ρ	95% CI	Word	ρ	95% CI
Sadness words					
traged*	**−.143**	**[−.146, −.140]**	**lost**	**−.014**	**[−.015, −.013]**
mourn*	**−.062**	**[−.064, −.060]**	**sad**	**−.013**	**[−.014, −.011]**
griev*	**−.055**	**[−.057, −.053]**	sobbing	−.012	[−.013, −.011]
lost	**−.055**	**[−.057, −.053]**	loss*	−.012	[−.013, −.011]
sadde*	**−.047**	**[−.049, −.045]**	depress*	−.010	[−.011, −.009]
Anxiety words					
craz*	**.058**	**[.056, .061]**	**doubt**	**.025**	**[.023, .026]**
obsess*	**.055**	**[.052, .057]**	**craz***	**.020**	**[.019, .021]**
terror	**.052**	**[.049, .054]**	**fearful**	**.013**	**[.012, .014]**
fearful	**.050**	**[.048, .052]**	**unsure**	**.013**	**[.012, .014]**
scare	**.039**	**[.029, .033]**	**obsess***	**.012**	**[.011, .013]**
Causality words					
since	**.088**	**[.086, .091]**	**used**	**.026**	**[.025, .028]**
used	**.039**	**[.037, .041]**	**reason***	**.022**	**[.021, .024]**
caus*	**.039**	**[.037, .041]**	**why**	**.018**	**[.017, .019]**
force*	**.032**	**[.030, .034]**	**motiv***	**.018**	**[.016, .019]**
use	**.021**	**[.019, .022]**	**source***	**.016**	**[.015, .017]**

Note: Words were categorized according to the Linguistic Inquiry and Word Count dictionary (Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007). For those cases in which different forms using a given root word were counted as instances of that word (e.g., *sadder, saddest,* and *sadden* counted toward *sadde** frequency), the table shows the root followed by an asterisk. Correlations were computed between word frequency and (a) spatial distance from Newtown and (b) time passed since the tragedy. Boldface indicates coefficients surviving false-discovery-rate correction at *p* < .05. CI = confidence interval.

correlated time (in seconds) and approximate distance (in miles) with frequencies of each of the words in the LIWC sadness, anxiety, and causality categories. Table 1 summarizes the results of these analyses by showing, for each category, the five words whose usage was most strongly associated with spatial distance and the five words whose usage was most strongly associated with the passage of time. We corrected for multiple comparisons within word category using the false-discovery-rate procedure (Benjamini & Hochberg, 1995). (For additional information about word-level patterns in use of affective words, see Fig. S1 in the Supplemental Material.)

Study 2: Abstract Thinking Evokes Affective Patterns Mirroring Effects of Time and Distance Observed in Tweets

Study 1 revealed a remoteness-associated shift from sadness to anxiety and suggested that increases in abstract thinking might be an intermediate causative factor bringing about this shift. To investigate this possible effect directly, we conducted a follow-up experiment testing the hypothesis that a specific type of abstract thought—thinking about

the broader causes of the Newtown shooting—can evoke a pattern of decreased sadness and increased anxiety. Because focusing on the abstract causes of tragedy should be particularly anxiety evoking if these causes are perceived as unresolved, we also asked if perceptions that the causes of the shooting were unresolved and that risk for similar tragedies was ongoing contributed to this pattern of increased anxiety. All study procedures were approved by the Columbia University Institutional Review Board.

Participants and design

Participants were 100 U.S. adults (61 women and 39 men; mean age = 35.5 years, *SD* = 10.9) recruited via Amazon's Mechanical Turk crowdsourcing platform during the week of November 11, 2013. We determined the sample size in advance so as to have 97% power to detect a medium (δ = 0.5) within-subjects effect and 80% power to detect the same size between-subjects effect at a one-tailed alpha of .05. After providing consent, participants were randomly assigned to either an abstract-construal condition, in which they were asked to type two to three
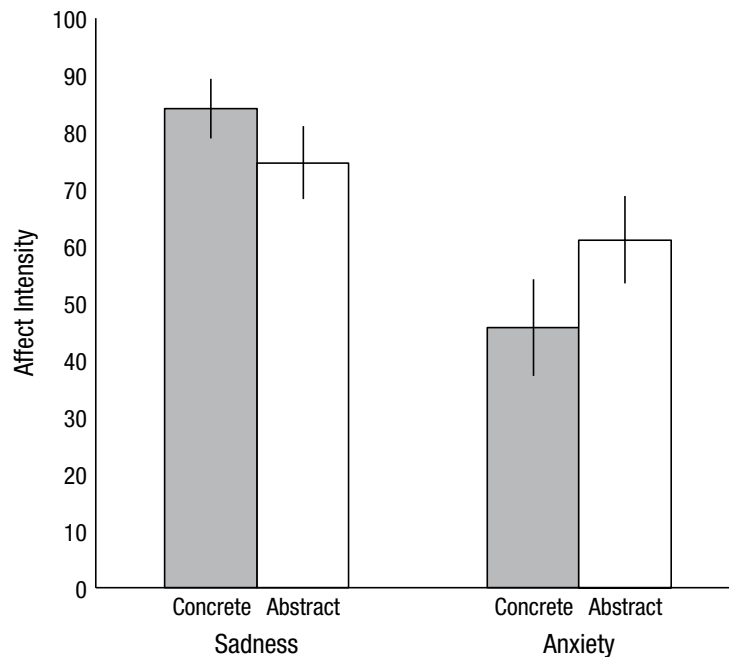
Fig. 3. Results from Study 2: mean ratings of sadness and anxiety in the concrete- and abstract-construal conditions. Error bars represent 95% confidence intervals.

sentences about the broader causes of the Sandy Hook massacre (i.e., why the tragedy happened), or a concrete-construal condition, in which they were asked to type two to three sentences about the event's concrete details (i.e., how the tragedy happened). Immediately following this manipulation, participants rated their current feelings of sadness and anxiety (order counterbalanced across subjects) on a 100-point sliding scale (0 = *not at all*, 100 = *strongest I have ever felt*). All participants also answered two questions meant to index their perception (0 = *disagree strongly*, 100 = *agree strongly*) that the causes of this tragedy remain unresolved and that risk for similar events is ongoing ("I believe that the factors that led to this event happening have not been resolved"; "I think that a similar tragedy is very likely to happen in the future").

Results

Manipulation check. Two coders blind to condition rated the texts generated during the construal-level manipulation on a 5-point scale (1 = *concrete*, 5 = *abstract*). This measure showed good interrater reliability (Cronbach's α = .86), and an independent-samples *t* test revealed that the manipulation of construal level elicited the intended pattern of thinking (concrete-construal condition: *M* = 2.31, *SD* = 1.13; abstract-construal condition: *M* = 3.80, *SD* = 0.89), *t*(98) = 7.07, *p* < .001, *d* = 1.43. Additionally, examination of LIWC variables revealed

that abstract-construal texts contained more causality words (*M* = 1.07, *SD* = 1.08) than did concrete-construal texts (*M* = 0.46, *SD* = 0.70), *b* = 0.85, 95% CI = [0.36, 1.34], *p* < .001.

Effects of construal level and emotion category. Next, we examined the effects of construal level (between subjects: abstract vs. concrete) and emotion category (within subjects: sadness vs. anxiety) on affect ratings by conducting a 2 × 2 mixed analysis of variance. This analysis revealed a main effect of emotion category, *F*(1, 98) = 74.1, *p* < .001, η_p^2 = .43, and a Construal Level × Emotion Category interaction, *F*(1, 98) = 17.1, *p* < .001, η_p^2 = .15, such that focusing on the abstract causes of this tragedy (rather than the concrete details) decreased sadness, *t*(98) = −2.23, *p* < .05, *d* = 0.45, but increased anxiety, *t*(98) = 2.62, *p* < .01, *d* = 0.53 (see Fig. 3 for means and associated confidence intervals). These findings indicate that, although thinking about the Newtown shooting generally evokes more sadness than anxiety (see Fig. 3), thinking about the event's abstract causes rather than its concrete details leads to a (between-group) shift in emotional tone away from sadness and toward anxiety, a pattern that mirrors the effects of spatial and temporal distance we observed in responses on Twitter.

Effect of perceived risk and lack of resolution. As expected, responses to the two questions that assessed perceived risk and lack of resolution of the tragedy's

causes were highly correlated (Spearman-Brown ρ = .51, $p < .01$), so we averaged these responses to derive a single summary score for each participant. This summary score showed high overall levels of perceived risk and lack of resolution ($M = 72.7$, $SD = 19.8$) that did not differ appreciably between the abstract- and concrete-construal conditions, $t(98) = 0.94$, $p = .83$, $d = 0.19$. However, regression analysis provided evidence suggesting that the construal-level manipulation moderated the relationship between this summary score (perceived risk and lack of resolution) and self-reported anxiety, interaction $b = 0.54$, 95% CI = [−0.04, 1.12], $p = .07$, such that greater perceived risk and lack of resolution was predictive of greater anxiety for participants in the abstract-construal condition, $b = 0.62$, 95% CI = [0.21, 1.04], $p < .005$, but not for those in the concrete-construal condition, $b = 0.08$, 95% CI = [−0.32, 0.49], $p = .68$. Although the fact that the interaction was only at the trend level limits certainty about the difference between the effects in the abstract- and concrete-construal conditions, this pattern of results suggests that anxiety elicited by focusing on this tragedy is driven in part by perceptions that its contributing factors are unresolved and that a similar event may occur in the future.

Discussion

In a large-scale observational study and follow-up experiment, we aimed to identify and explain the impact of time and space on emotional responses to the Newtown shooting. Some results were consistent with intuitive predictions drawn from the nonspecific distance hypothesis: Greater temporal and spatial distance were associated with decreases in word use reflective of tragedy-related thought, psychological immediacy, and overall intensity of emotional expression. However, our data also suggest novel updates to models of emotion and distance by showing that increasing temporal and spatial distance predicted a shift in emotional tone away from sadness and toward anxiety, a shift consistent with the construal-level hypothesis and inconsistent with the nonspecific distance hypothesis. Moreover, our results suggest that this shift (particularly the increase in anxiety) emerged in part because remoteness prompted higher-level consideration of the unresolved causes of the tragedy.

Implications for therapeutic and prevention initiatives

In a 2013 poll, 33% of U.S. parents (an 8% increase from 2012) reported fearing for their child's safety at school (Gallup, 2013). Understanding how particular emotions lessen, persist, or increase with increasing time and spatial distance may help identify more effective modes of individual- or societal-level therapeutic support. Because sadness and anxiety have distinct implications for behavior, building this understanding may also help identify factors that influence support for tragedy-prevention initiatives; temporal and spatial dynamics in feelings of sadness and anxiety, for example, may affect support for school safety policies or legislative change. Work examining the impact of construal level and emotional experience on political behavior may be particularly instructive.

Implications for emotion theory

More generally, these data highlight the importance of distinguishing between categories of negative emotion, adding to a tradition highlighting valence-independent influences of emotional appraisal processes (Lazarus, 1991; Lerner & Keltner, 2000; Oatley & Johnson-Laird, 1987). This study also complements work showing that distance can facilitate humor (McGraw, Warren, Williams, & Leonard, 2012), and similarly challenges models of reactivity that posit generic decreases in emotion with increasing psychological distance (e.g., Mühlberger, Neumann, Wieser, & Pauli, 2008). Likewise, the observation that abstract thinking had opposite effects on sadness and anxiety is not easily accounted for by models positing a simple reciprocal relationship between cognition and emotion (e.g., Drevets, 2000). Instead, it suggests that in the case of real-world tragedy, cognitive processes may commonly act to amplify the intensity of certain emotions (see Gross & Barrett, 2011).

Causes, construal level, distance, and emotion

In our experiment, we found that thinking about abstract causes of tragedy increased anxiety and decreased sadness. Because causal and abstract thinking co-occur (Rim et al., 2013), the cognitions our participants engaged in may have been similar to those that occur spontaneously in response to tragedy. However, we did not ask whether causal and abstract thinking have separable effects, nor did we quantify feelings of distance or uncertainty, which may have unique effects on emotion (see the Supplemental Material for analyses involving expressed uncertainty). In particular, although participants in Study 2 thought about abstract causes, it is likely that focusing on a concrete and familiar cause of tragedy may also elicit anxiety to the extent that this cause is perceived as presenting ongoing risk. However, whether time or spatial distance systematically increases attention to concrete causes is unclear. This is an empirical question worthy of further

study. In general, work designed to estimate independent and interactive effects of construal level, subjective distance, and causal thinking could deepen understanding of the mechanisms underlying the effects of distance on emotion.

Implications for psychological methods

Our approach is guided by the idea that psychological models with descriptive and explanatory power benefit from grounding experimental hypotheses in both theory and systematic observation of real-world behavior (Neisser, 1976; Reis & Gosling, 2010). Although for much of psychology's history the scope of naturalistic observation has been subject to steep practical limitations, the Internet resources we used allowed us to unobtrusively collect responses widely distributed in space and time, and to uncover systematic patterns of spontaneous behavior that may have been impossible to detect with traditional methods (see Yarkoni, 2012).

Limitations and future directions

Limitations of this research may provide direction for future work. First, the groups we sampled from differ from the general population in meaningful ways. For example, Twitter users are relatively young: In 2012, people ages 18 through 29 were most likely to use Twitter (Smith & Brenner, 2013). Work with more representative samples may reveal differences corresponding to development and life history.

Second, our protocol for collecting tweets posed limitations. Because collection was intermittent in time, we could not make strong inference about word use between or beyond the collection periods. For example, emotions may continue to change in meaningful ways more than 6 months after an event (see Norris et al., 2002). This limitation could be addressed with software facilitating uninterrupted access to the Streaming API. Also, because the API gives access to a sample of tweets that could differ meaningfully from Twitter's overall activity, protocols that access all of Twitter (see Morstatter, Pfeffer, Liu, & Carley, 2013) would be an improvement to our method. In addition, Twitter could be sampled by usernames (not keywords) to gather longitudinal data appropriate for quantifying within-person change.

There are also theoretical questions worth pursuing further. First, our analyses revealed that increased use of causality words was associated with increased use of anxiety words, but not decreased use of sadness words. One potential explanation for this pattern is that causality words mark a cognitive process contributing to anxiety (e.g., attention to abstract causes) more than to sadness,

which could be linked to a separable process (e.g., decreased attention to concrete loss).

Second, future work could sample a wider range of emotion categories (and life experiences) to deepen understanding of the relation between distance and emotion. The importance of this issue is suggested by our findings that use of anger words was frequent (see Fig. S1 in the Supplemental Material), increased over spatial distance, and remained high over time. Although this interesting pattern may have several potential explanations, it is consistent with prior research indicating that anger is a common response to tragedy (e.g., Lerner et al., 2003) and results from an affront for which blame can be assigned (Lazarus, 1991). Why the appraisal of this or other tragedies might vary with spatial but not temporal distance could be explored in future work considering effects of distance on anger, anxiety, sadness, and other emotions.

Third, we note that construing tragedy at a high level entails shifting one's focus from idiosyncratic features to more abstract qualities (like causes), which may elicit anxiety if perceived as threatening. This reasoning is supported by our finding that anxiety was associated with perceptions that the causes of the Newtown tragedy remain unresolved. Future studies could compare events that differ in the extent to which their causes are perceived as unresolved to determine how reactions to them may differ. Further, researchers could examine how information provided by news media influences the public's understanding of the details and causes of tragedies, their assessment of risk, and their resulting emotions.

Conclusion

Does emotion fade with time and spatial distance? Here, we suggest that time and distance can provide a bird's-eye view that alerts people to the scope of an unresolved threat. Although a complete understanding of the consequences of violent tragedy will require sustained efforts from diverse perspectives, we hope that by leveraging the complementary strengths of naturalistic and experimental approaches, psychological science will be able to contribute meaningfully to this enterprise.

Author Contributions

B. Doré and K. N. Ochsner designed the research. B. Doré, L. Ort, and O. Braverman collected and managed the data. B. Doré analyzed and visualized the data. B. Doré wrote the manuscript, and K. N. Ochsner provided critical revisions.

Declaration of Conflicting Interests

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Supplemental Material

Additional supporting information can be found at http://pss .sagepub.com/content/by/supplemental-data

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