Mapping Linguistic Shifts During Psychological Coping With the COVID-19 Pandemic

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Abstract
How does language change reveal the psychological trajectories of people coping with a COVID-19 infection? This study examined writings on social media over 12 weeks from people who self-reported having tested positive for COVID-19. People used fewer words reflecting anxiety and distancing but more words indicating reinterpretation over time. The language patterns for describing the experience of COVID-19 infections differed from those for describing other unrelated topics. The findings reveal the temporal dynamics of psychological adjustment to an unfolding crisis.

Keywords
psychological coping, linguistic shift, trajectory, cognitive reappraisal, COVID-19, growth models

It takes time to heal from traumatic events that significantly disrupt individuals’ lives. For example, the social stage model of coping posits that people experience recurring thoughts and emotions long after exposure to a distressing episode (Pennebaker & Harber, 1993). The more upsetting the emotional upheaval is, the more domains of people’s lives are affected, and the longer time is needed for them to recover from the stressful experience (Pennebaker & Harber, 1993). An overwhelming trauma can provoke intense emotions and persistent thoughts that take people months, if not years, to adjust psychologically. Coping strategies effective at one time may become maladaptive later. Thus, the psychological adjustment in response to a traumatic

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event is best considered a dynamic process, whereby people change their coping according to their emotional experience that unfolds over time.

Language can reveal how people cope with a traumatic event dynamically over time. Research has chronicled the changes in language patterns as people cope with traumatic events, such as terrorist attacks (Cohn et al., 2004) and romantic breakups (Seraj et al., 2021). As one of the deadliest and most disruptive crises in recent human history, the COVID-19 pandemic is “a unique, compounding, and multidimensional stressor” (Gruber et al., 2020, p. 410). It exerts widespread and profound impacts on daily routines without a foreseeable end date; it not only affects individuals’ health, relational, and economic well-being but also changes macrosystems by exacerbating political rifts, economic disparities, and stigmas against minority groups (Smith et al., 2022). Public health interventions are essential to contain disease spread, but they may inhibit people from access to protective resources known to buffer stress (Gruber et al., 2020). As a result, the COVID-19 pandemic may create a unique trajectory of psychological adjustment. This study chronicled the trajectory of people’s psychological adjustment through writings about their experience with COVID-19 infections.

Psychological Adjustment and Language use

One strategy to cope with traumatic experience—referred to as cognitive reappraisal—involves attempts to change the meaning of a traumatic event in a way that alters its emotional impact (Gross, 1998). Reappraisal can be achieved through two psychologically and neurally distinct routes (Ochsner et al., 2012). First, people can distance themselves from a traumatic event by adopting a detached, third-person perspective (Ochsner et al., 2012). Imagining upsetting situations as happening far away or from a third-person perspective has been found to reduce self-reported negative affect and biological indices of emotional arousals (Ayduk & Kross, 2008). Distancing involves brain regions implicated in spatial and attentional processes, indicating an effort to change spatiotemporal perspectives (Ochsner et al., 2012). Second, people can reinterpret the elements of a traumatic event. They may reframe a situation as less threatening or gain new perspectives that alleviate its emotional impacts. Reinterpretation mobilizes the brain regions responsible for selection and inhibition, requiring one to look up and select alternative meanings (Ochsner et al., 2012).

The two routes of cognitive reappraisal are also marked by distinct linguistic cues (Orvell et al., 2019). Psychological distancing has been linked to function words (Pennebaker & King, 1999), such as first-person singular pronouns and present adverbs. These function words reflect how (vs. what) information is communicated (Chung & Pennebaker, 2007). Greater use of first-person singular pronouns and present words indicates that a person is psychologically close to a stimulus, focusing on the here and now; by contrast, less use of these words indicates a distant perspective (Zhu, 2022).

Reinterpretation can be identified through a family of words that reflect people’s attempt to work through the problems for which they have limited understanding
These words include markers of different cognitive processes, such as causation, sense-making, and uncertainty. These cognitive processing words suggest that people try to make meaning from their traumatic experiences and re-organize their thoughts into a more coherent and less emotionally disturbing narrative (Pennebaker & Harber, 1993). For instance, Markowitz (2022, Study 1) found that scientists used more cognitive processing words in writings during the COVID-19 pandemic than before, revealing the academics’ attempts to construct meaning about heightened psychological distress.

The Current Study

It is difficult to study how cognitive reappraisal unfolds as people are experiencing a traumatic event in a real-world context. Cross-sectional studies using retrospective reports cannot reveal the temporal dynamics (Markowitz, 2022). Longitudinal studies often assess a few time points in a limited period, constraining researchers’ ability to map the precise trajectories of psychological responses in the weeks and months following a traumatic event. Although research has examined the trajectories of psychological coping with various emotional upheavals (e.g., Cohn et al., 2004; Seraj et al., 2021), the COVID-19 pandemic is a distinct type of traumatic event and may create a unique psychological timeline (Ashokkumar & Pennebaker, 2021). This study explores how linguistic markers of emotional experiences and cognitive reappraisals evolve following people’s initial disclosure of their COVID-19 infections.

Method

Data Collection and Curation

Data were collected from Reddit, a popular social media website where people share their concerns, interests, and hobbies. Posts on Reddit are organized into user-created communities called “subreddits.” In this study, I focused on r/COVID-19Positive, a subreddit for people affected by COVID-19 to exchange information and share stories and experiences about the disease. Data collection occurred between March 14th, 2020 and June 30th, 2021.

To create a sample for this study, I identified 115 users who self-reported having tested positive for COVID-19 and continuously wrote about their disease experience over 12 weeks following their initial disclosure. I also collected the users’ Reddit history, including posts on 1) subreddits that were generally related to COVID-19 but not specifically about experiences of infection and 2) subreddits unrelated to COVID-19. The historical posts were traced back to a year before the initial disclosure of COVID-19 infection.

Reddit does not collect users’ demographic information, but research estimates that active users tend to be younger, white, college-educated males (Pew Research, 2019). The percentage of male users (23%) was nearly twice that of female users (12%). About 36% of the active users are aged 18 to 29, followed by 22% aged 30 to 49.
and 13% aged 65 or older. Most users had some college education or a degree (46%). To further understand sample demographics, I read through the users’ first submission and coded their descriptions of gender, age, and health condition. Of 115 users, 37 (32.2%) disclosed their gender and 31 (27.8%) disclosed their age. Among the users who disclosed their demographic background, 21 (56.8%) were women and 16 (43.2%) were men. The average age was 35 years old ($SD = 12$, $Min. = 18$, $Max. = 59$). Among 22 users who disclosed their health condition, 13 self-identified as healthy and 9 mentioned pre-existing health issues.

Together, the 115 users contributed 10,620 posts to the r/COVID-19Positive subreddit. They also made 8,902 posts to the subreddits related to COVID-19 in general and 8,398 posts to other unrelated subreddits.

**Measures**

Users’ posts were analyzed with the Linguistic Inquiry and Word Count (LIWC, 2015 version; Pennebaker et al., 2015). The LIWC counts the number of words in grammatical and content categories based on predefined dictionaries and has been validated across various settings and languages (Boyd & Schwartz, 2021).

Anxiety was assessed by the percentage of anxiety-related words in a post. Anxiety was a salient and prevalent emotion when people were infected with COVID-19. Psychological distancing was assessed with five word categories: first-person singular pronouns, present-tense verbs, articles, discrepancy words, and words with more than six letters (Mehl et al., 2012). A composite score was calculated by averaging the standardized proportions of articles and words with more than six letters and the inverse proportions of first-person singular pronouns, present-tense verbs, and discrepancy words. Writing with lower scores indicates a mindset focused on the here and now, while writing with higher scores reflects a more distant, impersonal thinking style. Reinterpretation was assessed with the cognitive processing category in the LIWC, including words related to, for example, insight, causation, and uncertainty. Higher scores indicate that participants are more concerned with making sense of the situation and organizing thoughts in their writing (Cohn et al., 2004).

**Results**

**Descriptive Analyzes**

The number of posts decreased over time, with about 85% of posts being made to the subreddit within the first eight weeks since the initial disclosure (Figure 1). Users were most active in the first two weeks, making an average of 30 posts to the r/COVID-19Positive subreddit (95% CI [23.8, 34.8]). The level of activities reduced but remained high between weeks 4 and 8. By week 12, users contributed about 6 posts to the subreddit (95% CI [4.5, 7.6]).
The primary question of this study was how people’s anxiety and cognitive reappraisals unfolded over time through their writings about COVID-related experiences. Latent basis growth models were used to analyze the data (see supplementary materials online).

The predicted average proportion of anxiety words at one’s initial disclosure of the COVID-19 infection was 39% (Table 1). The average rate of change in anxiety words was a 14% decrease from the initial disclosure to week 12. The percentage of anxiety words fluctuated between the initial disclosure and week 12, with an initial drop by week 2 followed by a slight increase by week 4. The level of anxiety reflected in the users’ writings in the first four weeks was relatively stable compared to the level shown at their initial disclosure. The first significant decrease occurred between weeks 4 and 6. However, the percentage of anxiety words quickly bounced back between weeks 6 and 8 and was comparable to the percentage expressed in the writing during the first 4 weeks. The starkest decrease appeared between weeks 8 and 10, and the same level remained until week 12.

Figure 1. Plots of the number of posts over time. 
*Note.* The x-axis represents time, with 0 indicating the initial disclosure of COVID-19 infection. The y-axis represents the number of posts. The shaded area represents 95% confidence intervals.

**Linguistic Trajectories of Psychological Coping**

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For psychological distancing, the predicted average score at one’s initial disclosure was 0.30. The average rate of change was a 0.23 decrease between the initial disclosure and week 12. Unlike the trajectory of anxiety words, the shape of change in words reflecting psychological distancing was characterized by a sharp drop immediately following the initial disclosure. The level of distancing words remained low and stable between weeks 2 and 12.

For cognitive processing words, the trajectory progressed in a pattern opposite to that of words indicating psychological distancing. The predicted average score of cognitive processing words at one’s initial disclosure was 11.14, with an average increase of 1.17 across 12 weeks. The level of cognitive processing words remained high and stable between weeks 2 and 10, followed by a slight decrease in weeks 10 to 12.

Last, I explored whether the language pattern was unique to describing experiences of a positive COVID-19 infection (Figure 2). People used more anxiety and coping words when disclosing their infection than when describing topics unrelated to COVID-19 (i.e., baseline). The percentages of anxiety and cognitive processing words remained higher than the baseline for 12 weeks since the initial disclosure. By contrast, the use of psychological distancing words returned to the baseline two weeks after the disclosure.

People also used language differently when they discussed their positive infection as opposed to COVID-19 in general. Social media posts about positive COVID-19 infections contained more anxiety and cognitive processing words than those about the COIVD-19 in general during the first 10 weeks. But there were no differences in the use of psychological distancing words.

### Table 1. Latent Basis Growth Models Predicting Changes in Language Use.

| Parameters | Anxiety | Psychological Distancing | Cognitive Processing |
|------------|---------|---------------------------|----------------------|
|            | Est     | SE | Est | SE | Est | SE |
| **Model effects** | | | | | | |
| Intercept  | 0.39**  | 0.03 | 0.30**  | 0.05 | 11.14**  | 0.44 |
| Overall rate of change | −0.14**  | 0.05 | −0.23*  | 0.05 | 1.17*  | 0.58 |
| Interval rate: W0-W2 | 0.31 | 0.29 | 1.07**  | 0.05 | 1.34*  | 0.59 |
| Interval rate: W2-W4 | 0.26 | 0.29 | 1.01**  | 0.05 | 1.53*  | 0.66 |
| Interval rate: W4-W6 | 0.59*  | 0.28 | 0.99**  | 0.05 | 1.35*  | 0.60 |
| Interval rate: W6-W8 | 0.30 | 0.29 | 1.13**  | 0.05 | 1.37*  | 0.60 |
| Interval rate: W8-W10 | 0.99**  | 0.32 | 1.07**  | 0.05 | 1.37*  | 0.60 |
| Residuals   | 0.35 | 0.23 | 4.36 | 0.23 | 4.36 | 0.23 |

**Model fit**

| AIC | BIC | Log-likelihood |
|-----|-----|----------------|
| 636.04 | 687.63 | −307.02 |
| 198.66 | 250.26 | −88.33 |
| 4757.04 | 4808.64 | −2367.52 |

*Note. W = week, AIC = Akaike information criterion, BIC = Bayesian information criterion. N_{user} = 115; N_{message} = 10,583
a.p < .05, b.p < .01.*
Post-Hoc Analysis

I explored the themes of topics people described in their writings using Latent Dirichlet Allocation (Blei, 2012; see supplementary materials). Three themes were identified (Table 2). The first theme described symptoms of COVID-19, containing topics ranging from general, flu-like symptoms to more specific conditions. The second theme focused on disease care and recovery. People described their exercise, 

Figure 2. Plots of users’ language trajectories over time. 
Note. The x-axis represents time, with 0 indicating the initial disclosure of COVID-19 infection. The y-axis represents scores of language variables. Scores for anxiety represent the percentages of anxiety words. Scores for psychological distancing and cognitive processing were log-transformed. The shaded area represents 95% confidence intervals.

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dietary intake, and nutritional supplement during their recovery from COVID-19. They also discussed their experience with healthcare providers and measures taken to protect themselves and others in contact. The third theme was learning, where users shared the latest research about the disease and sought information from the community.

Table 2. Themes and Topics Extracted via Latent Dirichlet Allocation.

| Topics               | Sample Keywords | Examples                                                                                          |
|----------------------|-----------------|---------------------------------------------------------------------------------------------------|
| **Theme 1: Symptoms**|                 |                                                                                                  |
| General              | Fever, fatigue, sore | I experienced mild throat irritation and low-grade fever.                                       |
| Neurological         | Brain, MRI, fog  | I had some neurological symptoms, such as blurry vision, brain fog, and cognitive decline.        |
| Heart                | Heart, rate, tachycardia | My major symptoms include an elevated heart rate when I stand up or do any real activity.       |
| Disease onset        | Sick, begin, March | I began to feel sick in early March and went to get tested.                                     |
| Pain                 | Pain, burn, headache | What has been keeping me up recently is kidney pain. It subsides during the day but at night it wreaks havoc. |
| Taste & smell        | Smell, taste, lose | I had total loss of smell on day 3 and partial of taste.                                         |
|                      |                 | On day 14, I can smell most stuff on the room from a distance and taste is back at least 80%.      |
| Breath               | Breathe, oxygen, oximeter | Breathing feels empty at times, like breathing air through a straw.                              |
| Lung                 | Lung, pneumonia, inflammation | I went to hospital yesterday and it looks like I may have a clot in my lung. Depressing!     |
| **Theme 2: Care & Recovery** |                 |                                                                                                  |
| Exercise             | Exercise, walk, run | I can do regular light exercise such as walking long distances, but running is still difficult. |
| Food & drink         | Diet, tea, hydrate | Eating mostly low carb veggies, fish, eggs, and fats.                                           |
| Supplement           | Aspirin, Zinc, take | Taking vitamin C, D, and Zinc, best to start right away just in case.                         |
| Healthcare           | Doctor, hospital, nurse | The nurse was very sweet to take care of me.                                                  |
| Protection           | Mask, isolate, wear | Double mask and open a window or door even briefly.                                          |
| **Theme 3: Learning**|                 |                                                                                                  |
| Research             | Study, research, system | This is an evolving situation and there will need to be more time for research.             |
| Information. seeking | Read, question, experience | How long should I expect the symptoms to improve?                                             |

Note: Top keywords refer to the terms predicted to have strong relations with an identified topic in Latent Dirichlet Allocation.
The posts about symptoms occurred mostly in the early stage of the disease progression and declined slightly after the second week since the initial disclosure (Figure 3). Further, users increasingly posted about disease care and recovery, shared research about the disease, and sought advice from other users over time, with a marked increase in such communication activities within the first four weeks since the initial disclosure. The trajectories aligned with the changes in cognitive processing words, indicating that people worked through their experience with support from other members.

Discussion

Language is closely linked to many central processes undergirding psychological responses to the COVID-19 pandemic (Jucks & Hendriks, 2021). For example, recent work demonstrates that pronoun use can affect communal coping with COVID-19 (Tian et al., 2021) and that linguistic cues, coupled with prior beliefs, shape attributions about others (Schnepf et al., 2021). This study highlights the temporal dimension of the interplay between language and psychological processes. It chronicles the psychological trajectories of coping with a COVID-19 infection through language use on social media. The results showed that people used fewer words reflecting anxiety and psychological distancing but more words indicating reinterpretation over time. The language patterns for describing the experience of COVID-19 infections

Figure 3. Trajectories for thematic topics.
Note. The y-axis represents the predicted probability of a topic to occur in the texts at a given time. The x-axis represents time, with 0 indicating the initial disclosure of COVID-19 infection. The gray lines represent predicted trajectories daily, and the orange lines represent predicted trajectories bi-weekly.
differed from how people generally talked about COVID-19 and other topics. Last, the post-hoc analysis contextualized the language analysis by identifying topical themes in people’s writings and the evolution of those themes over time.

Being infected with COVID-19 triggered a surge in people’s anxiety, as anxiety words accounted for over one-third of the total words used in people’s initial disclosure. Anxiety related to COVID-19 infections appeared more enduring than anxiety induced by other traumatic events (e.g., Cohn et al., 2004). The prolonged experience of anxiety may result from a complex web of stressors, such as a life-threatening disease, heightened uncertainty due to the lack of clear and consistent health messages, and disrupted social connections (Gruber et al., 2020). For the current sample, the substantial drop in anxiety words did not occur until the 8th week after the initial disclosure. Anxiety may subside as people gain a better understanding of their health condition. Supporting this interpretation, the results showed that the trajectory of anxiety words mirrored the changes in the posts describing disease symptoms. It is also possible that regularly writing about one’s disease experience may help alleviate anxiety. Research shows that people who write about their emotional experiences for as little as 15 min a day can experience a noticeable improvement in psychological and physiological health (Pavlacic et al., 2019).

People engaged in psychological distancing and reinterpretation to cope with a COVID-19 infection, but these strategies unfolded in patterns opposite to that of anxiety. The use of distancing words was highest when people first wrote about their COVID-19 infection, immediately followed by a sharp decline. Two weeks after the initial disclosure, the proportion of distancing words in people’s writing about their COVID-19 infections was comparable to the proportion used in their posts about COVID-19 in general and other unrelated topics. By contrast, the use of words indicating reinterpretation increased over time, peaking in the 4th week since the initial disclosure. The level of these cognitive processing words remained close to the peak level until the 10th week.

Why do psychological distancing and reinterpretation unfold differently? One possible explanation is that some reappraisal strategies may be more suited than others to modulate emotions at a given moment. The changing conditions of the pandemic may create new stressors and stimulate anxiety to a level that cannot be addressed by adopting a distant perspective alone. Another explanation may be that reinterpretation is cognitively effortful. Distressed individuals need to work through emotional situations and construct alternative meanings about their emotional experiences. Whereas reinterpretation may not be deployed quickly, it may last for a longer period because of the mental efforts needed to understand the changing situation. The post-hoc analysis of topical themes supported this idea and showed that people increasingly discussed the latest research about the disease and sought information and advice from others.

This study is unique in its representation of time. Prior research maps psychological processes upon the time metric by which a traumatic event unfolds in the broader society. For example, Ashokkumar and Pennebaker (2021) analyzed the linguistic shifts on social media in the months since the onset of the COVID-19 crisis, with an emphasis on how the language changed in response to landmark events such as the
first death reported in the US and the World Health Organization’s declaration of a global pandemic. By contrast, this study used an individual timeline by which time zero represented the initial disclosure of one’s COVID-19 infection in the online community. This approach recognized the heterogeneity in people’s disease experiences and modeled the trajectories unique to individuals.

The study has important limitations. First, the study was based on a convenient sample from Reddit that tended to overrepresent users from North America (and the US in particular) and those of higher socioeconomic status (Pew Research, 2019). Therefore, the findings cannot generalize to explain the disease-related experience and coping process from the perspectives of the less privileged groups who are disproportionately affected by COVID-19. Future research should adopt a triangulation of methodologies to include diverse voices (Hargittai, 2020). Second, the study addressed how, but not why, psychological coping with COVID-19 changed over time. Future research should investigate the factors that account for inter-individual differences in the psychological trajectories. Third, the study examined social media posts separately and did not consider the social dynamics by which people made posts to interact with others. Future research is encouraged to examine, at a more granular level, how members of online communities use language to co-construct meaning and make sense of an ongoing traumatic event. Fourth, the study relied on users’ self-disclosure of COVID-19 infections and could not verify their diagnosis. Last, uncertainty remains regarding how the trajectories may appear differently when more longitudinally intensive data are used. Despite these limitations, the study offered a dynamic description of the unfolding psychological adjustment to a profound crisis.

Acknowledgments

I would like to thank three anonymous reviewers and Howie Giles for their substantive and insightful feedback, and Xuan Ma for her assistance with data curation.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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Supplemental material

Supplemental material for this article is available online.
Notes
1. A similar subreddit called r/COVID19 was not used because it focused on the scientific discussion of COVID-19 and prioritized information from academic publications and official press releases rather than personal narratives on disease-related experiences, emotions, and coping.
2. The r/COVID-19Positive subreddit was created on March 14th, 2020. Data were collected using the Pushshift Reddit application programming interface (Baumgartner et al., 2020).
3. I chose a 12-week period to maximize the possibility of chronicling the users’ linguistic shifts over their disease experiences. Empirically, fewer than 1% of the users continued posting messages in the community beyond 12 weeks.
4. I thank an anonymous reviewer for this suggestion.
5. The data and supplementary materials are available at https://osf.io/tq28d/?view_only=4e25c2bdbde9460a8755e5b390c6d8ad

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