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Information overload's double-edged sword effect on sense of safety: Examining the moderating role of hypervigilance

Wen Zhang[1] | Yue You[1] | Lei Wang[2] | Wei Liu[3] | Xichao Zhang[1]

[1]Faculty of Psychology, Beijing Normal University, Beijing, China

[2]Department of Leadership and Organization Management, Tsinghua University, Beijing, China

[3]Institute of Psychology, Erasmus University Rotterdam, Rotterdam, The Netherlands

Correspondence

Xichao Zhang, Faculty of Psychology, Beijing Normal University, Houzhu Building (1513), 19, Xinjiekou wai Street, Haidian District, Beijing 100875, China.
Email: xchzhang@bnu.edu.cn

Abstract

Since the COVID-19 pandemic outbreak, long-term overlooked motives concerning a sense of safety have become a primary concern. People's sense of safety largely depends on the information they receive. Indeed, a tsunami of information about the virus has been disseminated by all forms of media to people's electronic devices, thus permeating their lives. This study proposed that the over-abundance of information, known as information overload, could endanger individuals' sense of safety by increasing their rumination about COVID-19. However, it could also enhance their sense of safety by increasing their positive attitudes toward COVID-19 precautions. Furthermore, we proposed that individuals' hypervigilance could strengthen the relationship between information overload and rumination about COVID-19 and attitudes toward COVID-19 precautions. We tested these hypotheses using a cross-sectional survey study ($N = 403$) in February 2021 and a diary study ($N = 98$) in July 2021 in China. The results of both studies support the dual mediating paths of the relationship between information overload and sense of safety. We also found that hypervigilance moderated the relationship between information overload and rumination about COVID-19. Overall, our study offers insights into how social media may influence people's sense of safety and how individual differences in hypervigilance play a role in the process.

KEYWORDS

attitudes toward COVID-19 precautions, hypervigilance, information overload, rumination about COVID-19, sense of safety

1 | INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic caused a global health crisis that has had a profound impact on people's lives, and the way they perceive the world (Hussain, 2020). In 2021, although the national pandemic was basically under control, sporadic cases emerged in many parts of China (Ding & Zhang, 2022). All kinds of COVID-19 related information, including fast-changing statistics, daily briefings by the government, and expert commentaries captured people's attention and permeated their daily lives (Su et al., 2021; Tsoy et al., 2021). As proposed by

Rosenfeld et al. (2021), by disrupting people's lives, the pandemic may highlight what is essential to people, making them aware of their most implicit and fundamental motivations (e.g., Maslow, 1943; Schaller et al., 2017). Sense of safety is one of the most fundamental needs of humans (Maslow, 1948), and refers to individuals' perception of the safety of their living environments (Hahn & Murphy, 2008). For example, people rarely pay much attention to a sense of safety when life is relatively safe (Carroll et al., 2015). However, when life is under threat, people focus on their safety and well-being and that of their loved ones (Carnevale & Hatak, 2020).

Owing to the uncertainty, people sought COVID-19 related information to gain a sense of control (e.g., Chen et al., 2021; Dawson et al., 2006). Providing health information is important because it helps promote effective strategies to deal with disease (Shao et al., 2021). Additionally, Xu and Liu (2021) proposed that abundant information helps people to understand the risks and adjust their health behaviours. However, a deluge of media may also include unnecessary and even false information that potentially spreads panic (Nicomedes & Avila, 2020; Nja et al., 2017). This means that information overload, representing a state in which an individual's efficiency in using information is hampered by the amount of relevant and potentially useful COVID-19 related information that is available to them (Xu & Liu, 2021), could have a mixed impact on individuals' sense of safety. On the one hand, information overload gives rise to more affective rumination about COVID-19 and increases individuals' perceptions of the threat in their living environments as illustrated by a decreased sense of safety (Satici et al., 2020); on the other hand, information overload cognitively reminds individuals of the severity of COVID-19 and promotes a positive attitude toward COVID-19 precautions (e.g., Corpuz et al., 2020; Melki et al., 2022), thus empowering them to take control and strengthening their confidence in the safety of their living environments.

Additionally, individuals' responses to a crisis do not relate solely to the event itself but also to their characteristics (e.g., Árbol et al., 2021). As hypervigilant individuals are more likely to be alert to danger (Bernstein et al., 2015), we propose that they tend to ruminate more and become more cautious and thus develop stronger proactive attitudes toward adopting COVID-19 precautions. Furthermore, as individuals were exposed to COVID-19 related information both daily and over a relatively long period of time, their responses to information overload may differ from each other and also fluctuate on a daily basis (e.g., Caniëls et al., 2022). Thus, we proposed that the relationships exist at between- and within-person levels. Therefore, we conducted two studies: a cross-sectional study as illustrated in Figure 1a, and a diary study as shown in Figure 1b, to test our hypotheses at between and within-person levels respectively.

Our study contributes to the COVID-19 pandemic research in several ways. First, it contributes to the existing knowledge of individuals' psychological responses to the significant amounts of information during the COVID-19 pandemic. By going beyond exploring the adverse impact of information overload on sense of safety, our study offers a more comprehensive perspective that considers both positive and negative mechanisms underlying the relationship. Second, although some studies have addressed the relationship between the mass media's coverage of COVID-19 and individual well-being (Nicomedes & Avila, 2020), few have explored how people's sense of safety was influenced by the mass media during this period (Yoon et al., 2021). This relationship requires investigation because a sense of safety as a reflection of people's trust and confidence in their living environment has become an important motivation when people's lives are threatened by COVID-19 (Carroll et al., 2015).

2 | THEORY AND HYPOTHESES

2.1 | COVID-19 information overload

The global COVID-19 outbreak has led to an outpouring of ever-changing information (Valika et al., 2020). Each day, people read, hear, and watch COVID-19-related news covering virus variations, transmission routes, and unproven medical breakthroughs. Although the information shared through the mass media facilitates global communication and connects people more closely, the deluge of information also increases individuals' burden to recognise scientific, relevant, and valuable news (Graf & Antoni, 2021). During the COVID-19 pandemic, the resonance and chaos of the mass of information presented in the media has been described as the phenomenon of 'COVID-19 information overload' (Hong & Kim, 2020).

COVID-19 information overload has led to a series of psychological reactions (e.g., Graf & Antoni, 2021; Melki et al., 2022; Xu & Liu, 2021). Information overload may affect individuals' perceptions of the risks posed by a crisis event (Yamashita, 2012), whereas disease disasters tend to be perceived as riskier than other environmental problems (Yu & Xie, 2006). Since information overload is found to be associated with a loss of control over the situation and feelings of being overwhelmed (Bawden & Robinson, 2009), it is vital to investigate the influence of COVID-19 information overload on individuals' psychological reactions, such as their sense of safety.

2.2 | Parallel mediating effects of rumination and attitudes toward COVID-19 precautions

In line with the definition of rumination, rumination about COVID-19 refers to focussing repetitively and passively on COVID-19 related symptoms and their possible implications where attention is directed to the feelings related to the problem (Nikolova et al., 2021; Nolen-Hoeksema et al., 2008). Rumination usually occurs when individuals are confronted with a life stressor that is significant to them (Nikolova et al., 2021). Individuals are informed daily and even hourly of the development, variations, and transmission of the virus, and thus are reminded of the severity of COVID-19. Drawing on the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984), individuals continuously monitor their environments and evaluate the potential danger (primary appraisal) and their capacity to deal with the danger (secondary appraisal). Information overload about COVID-19 not only shows the potential threat of the pandemic to public health all over the world, but also reveals a relatively limited human capacity for dealing with the disease. Individuals appraise COVID-19 as a stressful threat and ruminate over the potential danger. Indeed, previous studies have shown that when confronted with continuous and frequent COVID-19-relevant information, individuals tend to experience intrusive ruminative thoughts (e.g., Bakker & Van Wingerden, 2021).

Furthermore, for people who ruminate over the aggravated situation, feelings of uncertainty and danger are more likely to occupy
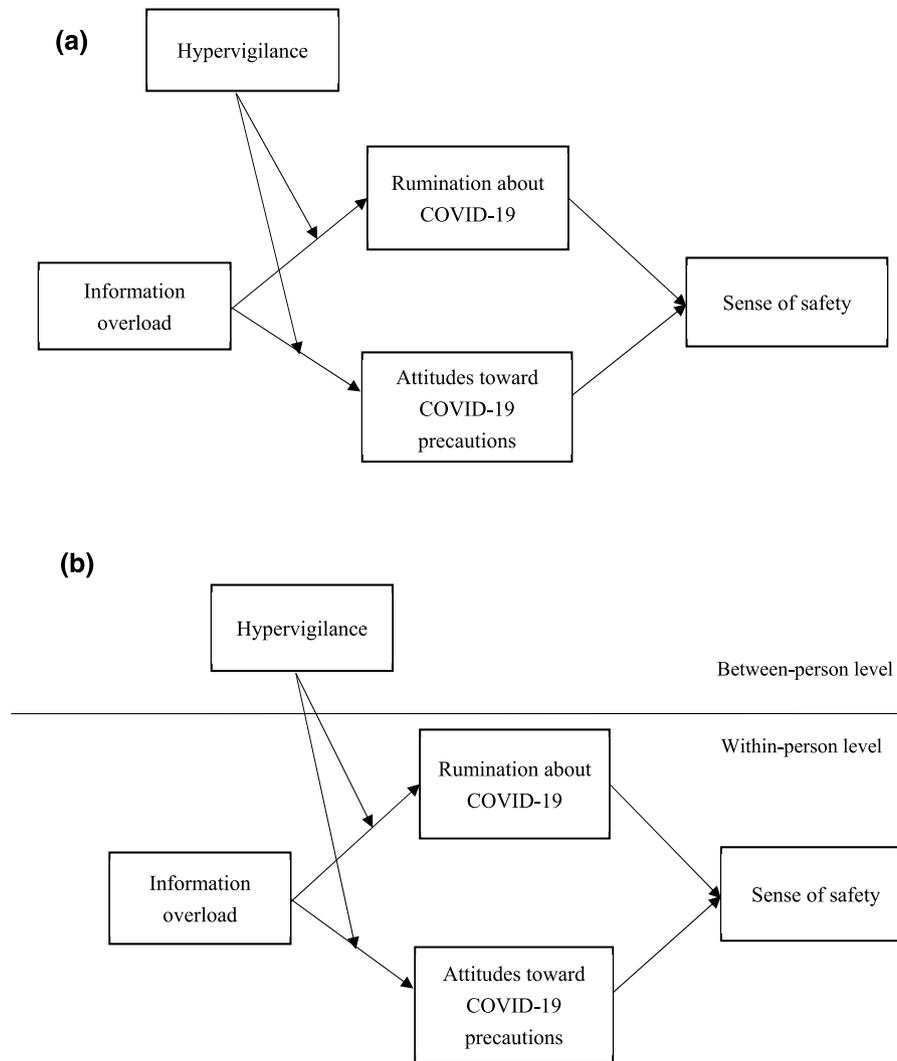
FIGURE 1   Conceptual models

their minds (Bakker & Van Wingerden, 2021). Sense of safety reflects individuals' general perception and belief of their safety in their living environments, and provides the backdrop against which they live (Hahn & Murphy, 2008). The outbreak of COVID-19 has made the aforementioned backdrop salient to people worldwide (Carnevale & Hatak, 2020). According to Carmeli et al. (2009), positive regard fosters individuals' sense of safety. In contrast, this sense is disturbed by uncertainty and relentless negative cues, such as ruminations about COVID-19. Taken together, we argue that information overload leads to rumination about the occurrence and severity of COVID-19, thus endangering people's sense of safety. As such, we hypothesised:

Hypothesis 1a *Information overload is negatively related to individuals' sense of safety via their rumination about COVID-19.*

Besides the affective rumination reaction, the current study proposed that individuals also develop an adaptive cognitive reaction (i.e., attitude toward COVID-19 precautions) to face COVID-19 information overload. Attitudes toward COVID-19 precautions refers to individuals' willingness to adjust their lifestyles to fight against and overcome the crisis (Gilstrap et al., 2016). For example, it signifies the degree to which an individual is willing to sacrifice their freedom to extend the quarantine or wear masks in public places (Salem et al., 2021). More exposure to COVID-19 information facilitates people's understanding of the necessity to take precautions by alerting them to the threat of the disease (Koh et al., 2021). Previous research has shown that spreading pandemic-related information enhances individuals' risk perceptions, helps shift their attention to health, and encourages them to cooperate consciously with pandemic prevention management measures (Vaughan & Tinker, 2009). The study of Hong and Kim (2020) has demonstrated that processing information about COVID-19 is beneficial for individuals' adoption of more preventative behaviours.

We argue that when individuals foster a more positive and proactive attitude toward COVID-19 precautions, they will experience more efficacy and confidence in defeating the pandemic. Proper attitudes toward COVID-19 precautions encourages individuals to

strictly follow safety standards, not only to ensure their own safety, but that of others (Hussain, 2020). When individuals believe they can protect themselves and others against the potential risk of COVID-19 by taking the necessary precautionary actions, they feel an enhanced sense of safety in their environment. Taken together, we hypothesised that COVID-19 information overload promotes proactive attitudes toward COVID-19 precautions and further strengthens individuals' sense of safety.

Hypothesis 1b *Information overload is positively related to individuals' sense of safety via their attitudes toward COVID-19 precautions.*

2.3 | Moderating role of hypervigilance

Hypervigilance is a 'panic-like state of being carefully watchful for possible danger or difficulties to an excessive degree' (Bernstein & Putnam, 1986, p. 727). Hypervigilance is associated with a range of functional impairments, particularly disturbances in cognition, attention, and threat appraisal. Previous literature has shown the extent to which the potential danger of the crisis event and individual differences, such as attitudes, awareness, and ability to withstand it, can threaten the general sense of safety (Buheji, 2018; Zajenkowski et al., 2020). In this study, we proposed that hypervigilance is a relevant individual difference when considering the influence of the COVID-19 pandemic on individuals' emotional and cognitive reactions.

In its extreme form, hypervigilance represents a 'panic-like state', in which individuals pay selective and focussed attention to unpleasant information (Janis & Mann, 1977). In other words, compared with others, hypervigilant individuals have higher levels of risk awareness and focus more on the early warning information that signals danger and interpret it as more threatening. Therefore, when faced with copious information on COVID-19, individuals with high levels of hypervigilance likely scan threatening information and dwell on it, constantly ruminating about COVID-19, and, thus, feel a lower sense of safety regarding their environment.

Conversely, hypervigilant individuals tend to detect threatening stimuli to protect themselves (Horvath & Morf, 2009) and respond quickly to avoid potential danger. It is challenging to cope with the chronic override of one's nervous system that accompanies hypervigilance without targeting a specific or severe danger. However, when COVID-19 intrudes on and permeates people's lives, they direct the hypervigilance toward real and tangible responses to keep themselves safe, such as washing hands, wearing masks, and maintaining a sufficient physical distance. In a similar vein, we proposed that when faced with information overload, individuals with high levels of hypervigilance will feel more positively toward COVID-19 precautions and experience a greater sense of safety. Thus, we hypothesised:

Hypothesis 2a *Hypervigilance moderates the positive relationship between information overload and rumination about COVID-19 in a*

way that this relationship is stronger in individuals with higher levels of hypervigilance.

Hypothesis 2b *Hypervigilance moderates the positive relationship between information overload and attitudes toward COVID-19 precautions, in a way that this relationship is stronger in individuals with higher levels of hypervigilance.*

Hypothesis 3a *Hypervigilance moderates the mediating effect of rumination about COVID-19 in the relationship between information overload and sense of safety, and this mediating effect is stronger (i.e., more negative) in individuals with higher levels of hypervigilance.*

Hypothesis 3b *Hypervigilance moderates the mediating effect of attitudes toward COVID-19 precautions in the relationship between information overload and the sense of safety, and this mediating effect is stronger (i.e., more positive) when individuals exhibit higher levels of hypervigilance.*

3 | RESEARCH OVERVIEW

We conducted two studies with complementary designs in China: Study 1 was a cross-sectional survey in February 2021, and Study 2 was a diary study in July 2021. Although China contained the spread of COVID-19 cases at relatively low levels in 2021, ongoing local cases were discovered and the media continuously broadcasted COVID-19 related information. Spector (2019) noted that a cross-sectional design is the most efficient method to provide initial evidence for a research question that deserves attention. Diary designs allow researchers to examine research questions that involve within-person processes (Lee & Almeida, 2015). The media broadcasting of COVID-19, perception of information overload, attitudes toward COVID-19 precautions, and sense of safety reflected a general trend that could vary on a daily basis. Therefore, we designed a cross-sectional individual-level (Figure 1a) and diary study (Figure 1b) to examine our hypotheses at the between- and within-person levels. The Mplus results of the currents studies have uploaded to: https://osf.io/nqthm/?view_only=8c22108e328a4445b88c7c8c837a4194.

4 | STUDY 1 METHOD

4.1 | Participants and procedure

We collected data through the Chinese online platform Credamo. Participation was voluntary, and confidentiality was ensured. We only included participants in the database whose records demonstrated a response rate greater than 95% to establish good sample quality. We also set an attention check item (i.e., 'Please choose option 4 for this item') in a random position in the questionnaire and excluded those who responded incorrectly. Each participant was

given 5 RMB ($.786) for completing the questionnaire. Following back-translation procedures (Brislin, 1970), all the scales were translated and back-translated by different individuals to achieve precision. Approval for Studies 1 and 2 was obtained from the ethics committee of the authors' universities, and all procedures used in this study adhered to the tenets of the Declaration of Helsinki.

After excluding three participants' data due to their incorrect answers to an attention check item, the final sample comprised 403 participants. The participants' average age was 29.940 (ranging from 20 to 53, $SD = 4.617$); 42.9% were male participants, and 57.1% were female participants. Most participants (79.2%) had a bachelor's degree, and some (10.4%) held a master's or doctoral degree. Most participants (59.2%) were unmarried, but in a relationship, about 27.3% were single, and 13.0% were married. In addition, about 35.5% of the participants spent less than 20 min each day reading or watching COVID-19-related information, 33.5% spent 20–40 min, 19.1% spent 40–60 min, and 11.2% spent more than 1 h. About 25.3% of the participants lived in Shangdong Province, 16.6% came from Hebei Province, 9.2% were from Jiangsu Province, 8.7% were from Beijing, and approximately 5.2% came from Shanghai.

4.2 | Measures

Information overload. In line with Xu and Liu (2021), we measured information overload using an adapted four-item version of Zhang et al.'s (2016) Information Overload Questionnaire, in which the original items used were explicitly adapted for COVID-19. An example was, *'I find that I am overwhelmed by the amount of coronavirus information I have to process.'* Participants were instructed to rate each statement from 1 (*strongly disagree*) to 7 (*strongly agree*). The Cronbach's alpha was 0.879 in the current study.

Rumination about COVID-19. Following Bakker and Van Wingerden (2021), we employed a modified four-item version of the rumination subscale of the Cognitive Emotion Regulation Questionnaire (Garnefski et al., 2001). The original items were specifically referring to COVID-19. An example item was, *'I am preoccupied with what I think and feel about the coronavirus.'* Participants were asked to rate each item on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). The Cronbach's alpha was 0.922 in the current study.

Attitudes toward COVID-19 precautions. We measured participants' attitudes toward COVID-19 precautions with the five-item attitude subscale of the knowledge, attitudes, and practice of the COVID-19 Precautions Scale that was modified and validated by Al Jasser et al. (2020). An example was, *'Masks should be worn most of the time to prevent the spread of infection.'* Participants were asked to rate each item from 1 (*strongly disagree*) to 7 (*strongly agree*). The Cronbach's alpha was 0.838 in the current study.

Sense of safety. The Psychosocial Safety Climate Scale developed by Hahn and Murphy (2008) assessed the participants' sense of safety. We used the original six-item scale and adapted it from a work context to a more general context. An example was, *'The health and safety of individuals is a high priority in the society in which I live.'* Participants were

asked to rate each statement from 1 (*strongly disagree*) to 7 (*strongly agree*). The Cronbach's alpha was 0.781 in the current study.

Hypervigilance. We used the five-item Brief Hypervigilance Scale developed by Bernstein et al. (2015) to measure participants' hypervigilance. An example was, *'I feel that if I don't stay alert and watchful, something bad will happen.'* Participants were asked to rate each description from 1 (*strongly disagree*) to 7 (*strongly agree*) to indicate to what extent they believed that the descriptions represented them. The Cronbach's alpha was 0.872 in the current study.

4.3 | Statistical analyses

First, we conducted confirmatory factor analyses with Mplus 7.4 (Muthén et al., 2017) to examine whether the measurement scales represented distinct constructs. We then employed path analysis using maximum likelihood estimation in Mplus to test our hypotheses. First, we constructed Model 1 with bootstrapping to test the parallel mediating effects of rumination about COVID-19 and attitudes toward COVID-19 precautions in the relationship between information overload and the sense of safety. In Model 2, we entered the interaction term using the XWITH command in Mplus to test the moderation and moderated mediation effects. Lastly, we addressed common method issue and tested an alternative model to ensure the robustness of our model.

5 | STUDY 1 RESULTS

5.1 | Confirmatory factor analyses

The five-factor (*information overload, rumination about COVID-19, attitudes toward COVID-19 precautions, sense of safety, hypervigilance*) model exhibited a good fit with the data ($\chi^2(192) = 459.806, p < 0.001$, SRMR = 0.054, CFI = 0.948, TLI = 0.932, and RMSEA = 0.059). This five-factor model was superior to any of the other alternative models, such as models combining two mediators in one factor ($\chi^2(218) = 1197.475, p < 0.001$, SRMR = 0.101, CFI = 0.815, TLI = 0.766, and RMSEA = 0.106). The results showed that the measures of the studied variables had good discriminant validity.

5.2 | Descriptive statistics and correlations

Table 1 shows the study variables' means, standard deviations, and correlations.

5.3 | Hypotheses testing

Table 2 displays the results showing that information overload was positively related to rumination about COVID-19 ($\beta = 0.541$, $p < 0.001$) and attitudes toward COVID-19 precautions ($\beta = 0.147$,

TABLE 1 Means, standard deviations, and correlations of the focal variables in study 1 (N = 403)

Variables	M	SD	1	2	3	4	5	6	7	8
1. Age	29.94	4.616	-							
2. Sex	1.57	0.496	−0.124*	-						
3. Marriage	1.73	0.455	0.579**	−0.103	-					
4. Information overload	3.222	1.170	0.135*	0.025	0.110	(0.879)				
5. Rumination about COVID-19	4.422	1.471	0.140*	0.143**	0.236*	0.504**	(0.922)			
6. Attitude towards COVID-19 precautions	6.036	0.750	0.153**	0.117*	0.190**	0.300**	0.354**	(0.838)		
7. Sense of safety	5.828	0.573	0.172**	−0.038	0.176*	−0.112*	−0.102*	0.259**	(0.781)	
8. Hypervigilance	3.282	1.210	0.060	−0.109*	0.073	0.335**	0.443**	0.172**	−0.161*	(0.872)

Note: Sex: 1 = male, 2 = female. Marriage: 1 = single, 2 = unmarried but in a relationship; 3 = married; 4 = divorced or widowed. Alpha internal consistency reliability coefficients appear on the main diagonal. Significance was determined using a two-tailed test.
*$p < 0.05$, **$p < 0.01$.

TABLE 2 Test of mediation and moderated mediation effects for study 1 (N = 403)

	Rumination about COVID-19		Attitudes toward COVID-19 precautions		Sense of safety	
	β	SE	β	SE	β	SE
Model 1: Mediating effects						
Information overload	0.541**	0.038	0.147**	0.049	0.129	0.067
Rumination about COVID-19					−0.210**	0.067
Attitudes toward COVID-19 precautions					0.197**	0.065
R^2	0.293**	0.041	0.086**	0.025	0.128**	0.040
Model 2: Moderated mediating effects						
Information overload (IO)	0.144	0.147	−0.168	0.110	0.079	0.049
Hypervigilance	−0.384*	0.058	−0.258	0.141		
IO × hypervigilance	0.136**	0.048	0.117**	0.036		
Rumination about COVID-19					−0.115**	0.040
Attitudes toward COVID-19 precautions					0.079	0.049
R^2	0.392**	0.054	0.138**	0.025	0.145**	0.018

Note: Bootstrap sample size = 10,000. Significance was determined using a two-tailed test.
*$p < 0.05$, **$p < 0.01$.

$p = 0.002$). Simultaneously, bootstrapping results showed that rumination about COVID-19 mediated the relationship between COVID-19 information overload and sense of safety (indirect effect = −0.114, 95% CI = [−0.190, −0.037]), and attitudes toward COVID-19 precautions mediated the relationship between information overload and sense of safety (indirect effect = 0.029, 95% CI = [0.003, 0.055]). Thus, Hypotheses 1a and 1b were supported. The dual-mediating model accounted for 12.8% of the variance of sense of safety.

The lower part of Table 2 displays the result that hypervigilance moderated the relationship between information overload and rumination about COVID-19 (β = 0.136, $p = 0.005$), supporting Hypothesis 2a. This interaction, which is depicted in Figure 2, was such that the
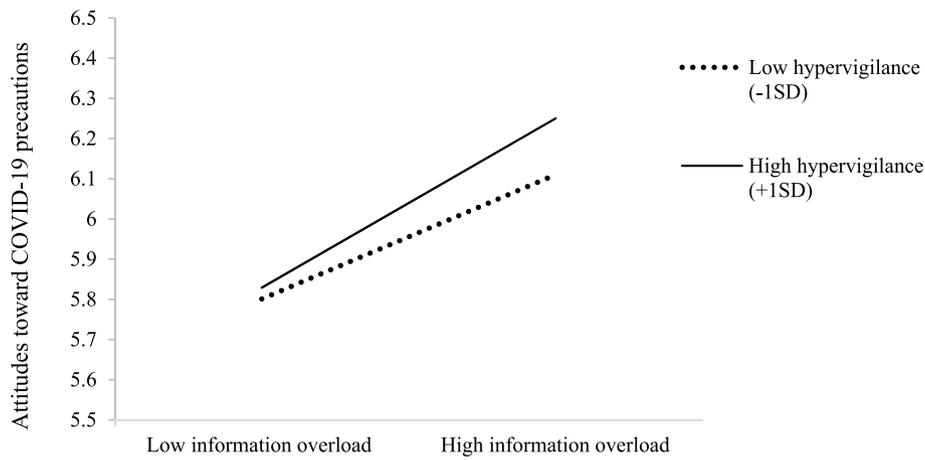
relationship between information overload and rumination about COVID-19 was more positive when hypervigilance was at 1SD higher than the average (simple slope = 0.761, $p < 0.001$) than at 1SD lower than the average (simple slope = 0.422, $p = 0.011$). We also found an interaction effect of information overload and hypervigilance on attitudes toward COVID-19 precautions (β = 0.367, $p = 0.001$). This relationship was stronger at 1SD higher than the mean hypervigilance (simple slope = 0.169, $p = 0.008$) than at 1SD lower (simple slope = 0.008, $p = 0.187$), supporting Hypothesis 2b (see Figure 3).

Furthermore, the results revealed that hypervigilance moderated the mediating effect of rumination about COVID-19 in the relationship between information overload and sense of safety (β = −0.016, 95% CI = [−0.036, −0.005]). Specifically, the mediating effect was
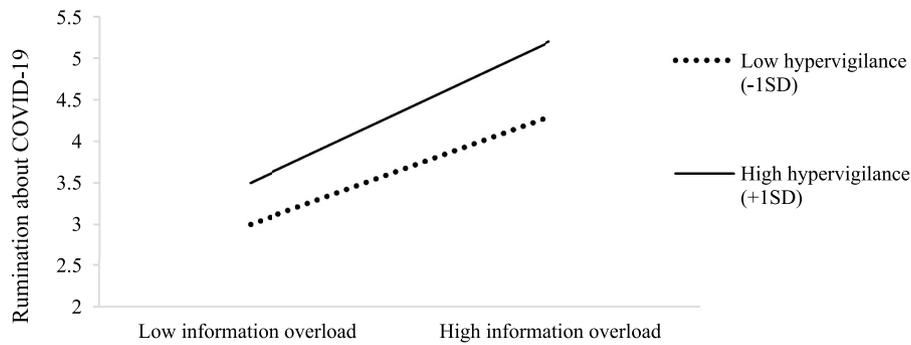
FIGURE 2 The moderating role of hypervigilance in the relationship between information overload and rumination about COVID-19 (study 1).

FIGURE 3 The moderating role of hypervigilance in the relationship between information overload and attitudes toward COVID-19 precautions (study 1).

more negative when participants had higher levels of hypervigilance (indirect effect = −0.098, 95% CI = [−0.179, −0.036]) than when they had lower levels of hypervigilance (indirect effect = −0.075, 95% CI = [0.135, −0.026]). Thus, Hypothesis 3a was supported. Hypothesis 3b was not supported because we did not find a moderated mediating effect of attitudes toward COVID-19 precautions in the relationship between information overload and sense of safety (β = 0.002, 95% CI = [−0.006, 0.013]). The moderated mediating model accounted for 14.5% of the variance of sense of safety.

5.4 | Supplementary analyses

To further examine the robustness of our model, we conducted several supplemental analyses. First, as the cross-sectional study may have succumbed to common method bias (CMB) (Podsakoff et al., 2003), we tested the severity of the potential bias by using the covariance method, in which we created a new construct—the common latent factor (e.g., Eichhorn, 2014). The result showed that the differences in standardised regression weights of constraint and unconstrained models were 0.200 for each latent variable (e.g., Afthanorhan et al., 2021). Therefore, we assumed that CMB did not substantially contaminate the current results. Second, we conducted

an alternative model to test whether hypervigilance could moderate the relationships between two mediators (i.e., rumination about COVID-19 and attitudes toward COVID-19) and sense of safety. The result showed that the interaction between rumination about COVID-19 and hypervigilance did not significantly relate to a sense of safety (β = −0.072, p = 0.088), nor did the interactive effect of attitudes toward COVID-19 and hypervigilance (β = −0.055, p = 0.245).

6 | STUDY 2 METHOD

6.1 | Participants and procedure

Participants were recruited through WeChat, China's most popular social media platform. With the help of the first and second authors' friends and colleagues, 124 participants scanned the QuickMark code in an advertisement that described the study's purpose and procedure. Specifically, participants were informed of the time length (i.e., 3 weeks) of the study and encouraged to take part in the entire process. Participation was voluntary, with anonymity guaranteed. A research assistant randomly assigned each participant a three-digit number to match them individually with their data. A week before

the formal diary study, the research assistant sent a survey link to participants to ask them to complete a general background survey that included age, sex, education, marriage status, locations, and hypervigilance. The study lasted for 2 weeks (i.e., 10 working days). Links to daily surveys (involving COVID-19 information overload, rumination about COVID-19, attitudes toward COVID-19 pre- cautions, and sense of safety) were sent to participants at 6 P.M. Participants were required to complete each day's survey before the end of the day. Each participant was offered monetary compensation ($.47) once they completed the survey at the end of each working day. Those who completed more than 8 days' surveys were entered into a lottery for a chance to win one prize of $18.86, two prizes of $10.38, and three prizes of $3.14.

Of the 124 participants who completed the background infor- mation survey, 26 were removed from the analyses as they did not complete any daily surveys or they only completed less than four daily surveys. We further interviewed 10 participants who completed less than four daily surveys for their dropout reasons and six of them responded that they were too busy and sometimes forgot to com- plete the surveys, and the other four people indicated that answering the same survey each day was relatively tedious. Our final sample included 980 observations nested within 98 individuals. Participants' average age was 29.970 years old (SD = 5.589); 43.9% were men, and 56.1% were women. Nearly half (48.9%) of the participants had a bachelor's degree, and 22.3% held a master's or doctoral degree. Approximately 51.4% of the participants were unmarried, and 22.9% were married. Among the participants, 31.5% were from Jiangsu Province, 27.4% were from Beijing, 15.3% came from Shanxi Prov- ince, and approximately 9.7% were from Hebei Province.

6.2 | Measures

All the study variables (i.e., information overload, rumination about COVID-19, attitudes toward COVID-19 precautions,

hypervigilance) were assessed with the same measures as in Study 1. The only difference was that, except for hypervigilance, all the variables were adapted to a daily base. Table 3 shows the average Cronbach's alpha for each scale as it varied across 10 days.

6.3 | Statistical analyses

In accordance with Study 1, all the analyses were conducted in Mplus 7.4. We first conducted multilevel confirmatory factor ana- lyses (MCFA) to test the differentiability of study variables. Further, we conducted multilevel analyses to reduce bias in the estimates of standard errors of all coefficients at the within-person level. Specifically, we adopted multilevel path analyses in the framework of multilevel structural equation modelling (MSEM) to test our hypotheses. Compared to traditional multilevel modelling (MLM), MSEM can effectively address problems of conflation or bias of the indirect effect (Preacher et al., 2010). In Model 1, we followed Bauer et al.'s (2006) recommendations for testing medi- ation (1-1-1) in a multilevel model with bootstrapping. In Model 2, we tested the multi-level moderated mediation model. Finally, we conducted alternative analyses to test the robustness of the cur- rent model.

7 | STUDY 2 RESULTS

7.1 | Multilevel confirmatory factor analyses

The results of MCFA showed that the hypothesised five-factor model had a reasonable fit with the data (χ^2(380) = 3528.070, $p < 0.001$, SRMR = 0.062, CFI = 0.930, TLI = 0.910, and RMSEA = 0.065). Loading any pair of these variables resulted in a poorer fit (best fitting alternative model, with rumination about COVID-19 and

TABLE 3 Means, standard deviations, and correlations of variables in study 2 (day-level: N = 861–970; between-person level: N = 98)

Variables	M	SD	ICC	1	2	3	4	5	6	7	8
1. Age	29.970	5.589		-							
2. Sex	1.560	0.496		0.006	-						
3. Marriage	1.42	0.795		0.544**	0.075*	-					
4. Information overload	3.971	0.789	52.2%	0.093**	0.084*	0.091*	(0.826)	0.332**	0.275**	−0.108*	
5. Rumination about COVID-19	4.470	1.650	61.2%	0.021*	0.124**	0.022	0.522**	(0.910)	0.208**	−0.200**	
6. Attitudes toward COVID-19 precautions	6.411	1.002	36.4%	0.189**	0.127**	0.026*	0.441**	0.431**	(0.819)	0.188**	
7. Sense of safety	5.215	0.876	41.8%	0.127**	0.071*	0.107**	−0.312*	−0.278**	0.314**	(0.761)	
8. Hypervigilance	3.109	0.804		−0.105*	−0.003	0.024	0.235**	0.363**	0.222**	−0.253*	(0.882)

Note: Sex: 1 = male; 2 = female. Marriage status: 1 = single; 2 = unmarried but in a relationship; 3 = married; 4 = divorced or widowed. Correlations above the diagonal are within–person correlations; those below the diagonal are between–person correlations. The averages of the alpha internal consistency reliability coefficients appear on the main diagonal. Significance was determined using a two-tailed test.
*$p < 0.05$, **$p < 0.01$.

attitudes toward COVID-19 precautions combined as one factor: $\chi^2(420) = 3741.996$, $p < 0.001$, SRMR = 0.066, CFI = 0.865, TLI = 0.832, and RMSEA = 0.072).

7.2 | Descriptive statistics and correlations

Table 3 presents the descriptive statistics and variable correlations. The intra-class correlation (ICC) results showed that all the within-person variables displayed a salient amount of variance at the within-person level versus the between-person level; thus, it was suitable for conducting the study's multilevel analyses.

7.3 | Hypotheses testing

Table 4 lists the multilevel path modelling results for our hypothesised dual-path model. The results showed that at the within-person level, information overload was positively related to both rumination about COVID-19 ($\beta = 0.259$, $p < 0.001$), and attitudes toward COVID-19 precautions ($\beta = 0.285$, $p < 0.001$). The indirect effect of information overload on sense of safety was negatively mediated by rumination about COVID-19 (indirect effect = −0.042, 95% CI = [−0.066, −0.018]) and positively mediated by attitudes toward COVID-19 precautions (indirect effect = 0.035, 95% CI = [0.005, 0.065]). Simultaneously, at the between-person level, we also found the indirect effect of rumination about COVID-19 in the relationship

between information overload and sense of safety (indirect effect = −0.203, 95% CI = [−0.395, −0.011]), and the positive indirect effect of attitudes toward COVID-19 precautions in the relationship between information overload and sense of safety (indirect effect = 0.116, 95% CI = [0.010, 0.022]). These results supported Hypotheses 1a and 1b.

We then tested the moderating effect of hypervigilance in Model 2. The results showed that hypervigilance moderated the positive relationship between information overload and rumination about COVID-19 ($\beta = 0.205$, $p = 0.046$), but not its relationship with attitudes toward COVID-19 precautions ($\beta = 0.019$, $p = 0.706$). As illustrated in Figure 4, when hypervigilance was 1SD higher than the average, the simple slope of information overload was more positive ($\beta = 0.490$, $p < 0.001$) than when hypervigilance was at 1SD lower ($\beta = 0.071$, $p = 0.031$). Thus, Hypothesis 2a was supported, whereas Hypothesis 2b was rejected.

Furthermore, hypervigilance moderated the mediating effect of rumination about COVID-19 in the relationship between information overload and sense of safety ($\beta = -0.050$, 95% CI = [−0.099, −0.001]). Specifically, the mediating effect of rumination about COVID-19 was more negative at 1SD higher levels of hypervigilance (indirect effect = −0.068, 95% CI = [−0.106, −0.030]) than at 1SD lower levels (indirect effect = −0.018, 95% CI = [−0.050, 0.014]), supporting Hypothesis 3a. We did not find a moderated mediating effect of attitudes toward COVID-19 precautions in the relationship between information overload and sense of safety ($\beta = 0.003$, 95% CI = [−0.013, 0.020]); therefore, Hypothesis 3b was not supported.

TABLE 4 Test of mediation and moderated mediation effects for study 2 (day-level: $N = 861–980$; between-person level: $N = 98$)

	Rumination about COVID-19		Attitudes toward COVID-19 precautions		Sense of safety	
	B	SE	β	SE	β	SE
Model 1: Mediating effects						
Information overload	0.259**	0.043	0.285**	0.044	0.596**	0.045
Rumination about COVI-19					−0.163**	0.036
Attitudes toward precautions					0.122*	0.052
Level 2 variance (individual)	0.119**	0.026	0.605**	0.090	0.123**	0.032
Level 1 variance (day)	0.207**	0.021	0.242**	0.034	0.189**	0.018
Model 2: Moderated mediating effects						
Information overload (IO)	0.283**	0.049	0.305**	0.048	0.617**	0.038
Hypervigilance	−1.910*	0.102	−0.024	0.128		
IO × hypervigilance	0.205*	0.102	0.019	0.049		
Rumination about COVID-19					−0.151**	0.034
Attitudes toward precautions					0.103*	0.051
Level 2 variance (individual)	1.437**	0.333	0.746**	0.102	0.434**	0.071
Level 1 variance (day)	0.281**	0.019	0.244**	0.036	0.190**	0.017

Note: Attitudes toward precautions = attitudes toward COVID-19 precautions. Coefficients in the current table represent within person effects.

*$p < 0.05$, **$p < 0.01$.
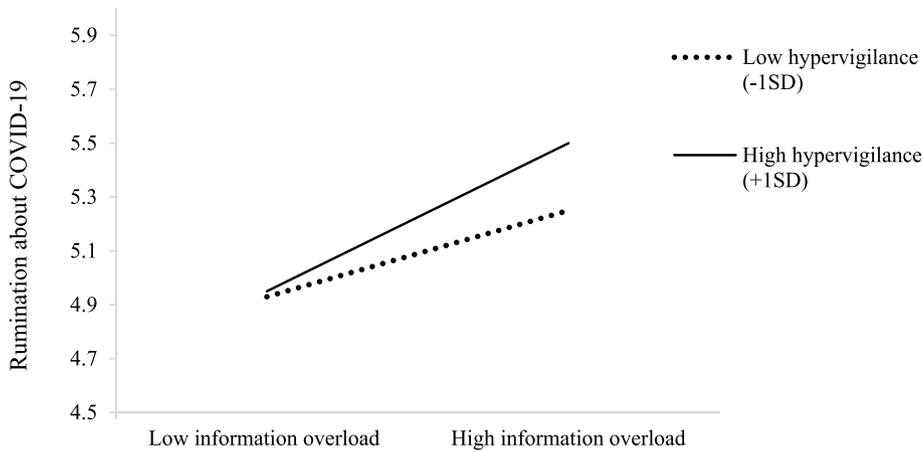
FIGURE 4 The moderating role of hypervigilance in the relationship between information overload and rumination about COVID-19 (study 2).

7.4 | Supplementary analyses

Following Study 1, we conducted several supplementary analyses to test the robustness of our model. First, as self-reporting in most diary study approaches can also render CMB a potential concern (Podsakoff et al., 2012), we added a common latent factor. The result showed that the changes in the standardised regression were less than 2.00 for the focal latent variables (e.g., Afthanorhan et al., 2021). Thus, we assumed that Study 2 does not have severe CMB. Second, we constructed an alternative model to test whether hypervigilance moderated the relationships between two mediators (i.e., rumination about and attitudes toward COVID-19 and a sense of safety). We found that the interaction between COVID-19 rumination and hypervigilance was not significant in predicting a sense of safety ($\beta = -0.078$, $p = 0.121$), nor was the interactive effect of attitudes toward COVID-19 and hypervigilance ($\beta = -0.053$, $p = 0.101$).

8 | DISCUSSION

Through two studies, our research revealed that information overload was negatively related to individuals' sense of safety via their rumination about COVID-19 and positively related to individuals' sense of safety via their proactive attitudes toward COVID-19 precautions at between- and within-person levels. That is, the current study indicated the double-edged effect of information overload on safety through two parallel paths existing in different individuals and on different days within the same person. Excessive information of COVID-19 may drag individuals into affective rumination of the virus's potential damage and threaten their sense of safety (e.g., Bakker & Van Wingerden, 2021; Huy, 1999). However, individuals also benefit from information overload even on days when they are overwhelmed by information, because it reminds them of the severity of the virus and informs them of additional preventional strategies (Vaughan & Tinker, 2009). In this way, they develop more proactive attitudes toward precautions. Such attitudes, accompanied by sense of control, could make them feel safer (Dawson et al., 2006).

Our results further revealed that at both the between- and within-person levels, hypervigilance strengthened the negative relationship between information overload and sense of safety via rumination about COVID-19. However, the moderation effect was not consistently found in the relationship of information overload and attitudes toward COVID-19 precautions across the two studies. Neither of the studies discovered the moderated mediating effect of attitudes toward COVID-19. In other words, the positive side of information overload for hypervigilant individuals was less obvious. We speculate that there might be two reasons for the inconsistencies. First, as hypervigilance implies a more sensitive perception for informational threats and a lower threshold for crisis warning (Bernstein & Putnam, 1986; Janis & Mann, 1977), hypervigilant individuals may be consumed by the threatening information, and lack the motivation to select or seek useful information to cope with or prevent the crisis. For individuals with higher levels of hypervigilance, when they are faced with overloaded information generally, or on particular days, they are less likely to feel safe as they may constantly succumb to affective rumination about the danger, and it might be difficult for them to adjust their cognition positively (Janis & Mann, 1977). Second, we assume that this inconsistency arises because when a precautionary attitude is established and internalised in an individual's mind via a day-to-day precautionary attitude, whether the individual is hypervigilant or not, they will be equally serious about taking the relevant precautions.

8.1 | Theoretical implications

This study contributes to the research on psychological responses to COVID-19 in several ways. First, our study addressed the critical question of how COVID-19 information overload during the pandemic influences individuals' personal sense of safety. During the pandemic, commercial and mass media intensively circulated a significant amount of information on the coronavirus, and such information has been constantly recommended to individuals through artificial intelligence based on algorithms and their historical data (Pavlik, 2016). As such, individuals may passively receive an overload

of information regarding COVID-19. Our study contributes to the literature by illustrating that this kind of overload can be both detrimental (via rumination about COVID-19) and beneficial (via attitudes toward COVID-19 precautions). This finding highlights the importance of viewing and evaluating information overload more holistically. Specifically, the pervasiveness of COVID-19-related information can draw individuals' attention to the crisis event, and repetitive rumination can sabotage their sense of safety. Simultaneously, exposure to information overload also alerts individuals and encourages a positive attitude toward COVID-19 precautions, thus cultivating a higher sense of safety.

Additionally, our work offers a more comprehensive and subtler framework that considers individuals' characteristics (i.e., hypervigilance). As Billings et al. (1980) noted, an individual's reactions depend on the nature of the crisis and their personality, awareness, and coping abilities. This consideration is especially important when considerable amounts of information are easily accessed and automatically recommended to individuals. Thus, people may have fewer opportunities to consciously select essential or relevant information. Our study revealed that individuals with higher levels of hypervigilance might ruminate more about the negative aspect of the COVID-19 pandemic when faced with information overload.

Furthermore, the specific nature of the complementary designs of our cross-sectional and diary studies also provided some insights that allowed us to understand individuals' psychological responses to COVID-19 information overload. The cross-sectional study reflected the general tendency of individuals' perceptions, feelings, and reactions over time. In contrast, the diary study captured individuals' dynamic psychological states over a relatively short period (Liu et al., 2021). The results of both studies demonstrated the double-edged sword effect of information overload and the moderating effect of hypervigilance in the relationship between such overload and rumination about COVID-19. The corroboration of the two studies' results strengthened the robustness of our hypotheses.

8.2 | Practical implications

This study's findings have some practical implications. First, our study revealed that besides the sudden 'black swan event', an event that is hard to predict but has an outsized impact (Mishra, 2020), the mass of information related to such an event may also profoundly influence individuals' psychology. When broadcasting news, different media platforms should consider the public's responses. Our study showed that information overload might have a double-edged sword effect on individuals' sense of safety. Social and mass media should take advantage of the technology era to broadcast more succinct scientific, accurate, and authentic information. Moreover, instead of continuously and repetitively broadcasting news that instigates discrimination or chaos, media platforms should also provide and share valuable strategies to help individuals to physically and psychologically protect themselves (Kim, 2014). For example, the media could invite those who have coped well during the COVID-19

pandemic to share their personal experiences, and such information can convey a sense of unity and warmth, which are vital in the pandemic context.

Second, our study also revealed that individuals should not succumb to rumination. Living in an era where information pervades our lives, individuals may immerse themselves in the ocean of media and available information (Xu & Liu, 2021). However, people should remember that not all information is necessary or authentic, and information overload may cause them to ruminate about COVID-19. Such rumination can be harmful because it may endanger their sense of safety. Therefore, individuals should be cautious of the anxiety, false cognition, and information overload related to the pandemic. They should also establish appropriate periods to read, listen to, or watch COVID-19-related information to avoid further indulgence in rumination.

Finally, our study showed that individuals' characteristics, such as hypervigilance, are an essential factor that may regulate their psychological responses to event-related information and negative rumination behaviours. Individuals with higher levels of hypervigilance should focus less on COVID-19 information overload and instead channel their vigilance toward adopting more precautionary measures. Moreover, as previous literature has shown that mindfulness may help reduce the adverse effects resulting from crisis-related information (Roemer et al., 2015), hypervigilant individuals should increase their mindfulness capacity by paying more attention to what is happening and their surrounding environment in the present moment, instead of sinking into rumination of the dangers of the crisis.

8.3 | Limitations and future studies

The present research presents several limitations that should be acknowledged and improved upon in further studies. First, our study focussed only on information overload, neglecting the content of the information. Following the 2003 outbreak of SARS, Rothkopf (2003) proposed the concept of the 'information epidemic' (i.e., *infodemic*), which refers to the fear, speculation, and rumours that are based on actual events that have happened. The infodemic was rapidly amplified and transmitted by modern information technology. After the outbreak of COVID-19, it became difficult for individuals to obtain comprehensive, authentic, and practical information, and they were likely to be exposed to exaggerated or false information (e.g., He et al., 2021; Naeem & Bhatti, 2020). The content of information profoundly influences individuals' reactions (Jalali & Mohammadi, 2020; Parikh et al., 2020). Therefore, future studies should integrate information asymmetry, false information, and other characteristics related to information content into the research.

Second, there was room for measurement improvement in the present study. Study 1 adopted a cross-sectional design, which cannot reveal a causal relationship. Individuals who ruminate frequently may be more likely to browse through large amounts of

news information. Therefore, future studies should use a cross-lagged design to reflect the sequential relationships of the investigated variables more accurately. Additionally, all the data were self-reported, which may leave our results vulnerable to bias, such as CMB (Podsakoff et al., 2012). However, our statistical analyses showed that CMB was not a significant issue. Therefore, future studies could reduce the risk of CMB by adding alternative ratings or objective data, for example, by using mobile app records to reflect participants' indulgence in information seeking.

Lastly, our study only measured individuals' sense of safety as an outcome, and there might be more potential outcomes. For example, information overload may also relate to individuals' emotions, well-being, and perceptions of their lives (Kross et al., 2013). Future studies could explore other important outcomes of consuming crisis-related information. Additionally, although we discovered two different mechanisms between information overload and sense of safety, other mechanisms might be at play. For example, Deters and Mehl (2013) found that social networking effectively reduces individuals' loneliness. Reduced loneliness may increase individuals' trust in others and, as a result, increase their sense of safety. Furthermore, a previous study (Xu et al., 2016) found that mindfulness might help alleviate adverse outcomes in crisis. Future studies should test the alleviating effect of mindfulness when individuals indulge themselves in browsing and ruminating about COVID-19 information and conduct mindfulness-based interventions.

9 | CONCLUSION

This study aimed to investigate individuals' psychological responses to the large amounts of information disseminated during the COVID-19 pandemic. Specifically, we explored how and under which conditions information overload might influence individuals' sense of safety. The results showed that information overload can be detrimental owing to individuals' rumination about COVID-19, but can help cultivate proactive attitudes toward COVID-19 precautions. Furthermore, hypervigilance exaggerated the influence of information overload on individuals' COVID-19 rumination.

CONFLICTS OF INTEREST
The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organisation or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

DATA AVAILABILITY STATEMENT
Data is available at the OSF: https://osf.io/nqthm/?view_only=8c22108e328a4445b88c7c8c837a4194.

ETHICS STATEMENT
Approval for the study was obtained from the ethics committee of Beijing Normal University. All procedures used adhered to the tenets of the Declaration of Helsinki.

ORCID
Lei Wang https://orcid.org/0000-0001-6969-2269
Xichao Zhang https://orcid.org/0000-0001-9630-0988

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