Emerging Infectious Outbreak Inhibits Pain Empathy Mediated Prosocial Willingness

Siqi Cao

CAS Key Laboratory of Behavioral Science, Institute of Psychology

Yanyan Qi

Zhengzhou University

Qi Huang

Beijing Normal University

Yuanchen Wang

Rochester university

Xinchen Han

University of Macau

Xun Liu

CAS Key Laboratory of Behavioral Science, Institute of Psychology

Haiyan Wu (✉ haiyanwu@um.edu.mo)

University of Macau

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Abstract

Background

The pandemic of COVID-19 sets off public psychological crises and impacts social functioning. Pre-pandemic research has shown that as the mental resource wears out under long-term distress, empathy exhaustion will happen. While prosocial activities are positively linked to empathy, quantitative research on the pandemic's effect on empathy and prosocial willingness has been insufficiently examined. Prosocial behaviors are carried out during a life-threatening time to promote communication and encourage community members to survive emergencies such as food shortages and natural disasters.

Methods

This study examined the shifts in emotion, empathy and prosocial behaviors between the pre-pandemic and pandemic era in China. Before (N = 520, 11/21/2019-11/23/2019) and after (N = 570, 2/23/2020-2/24/2020) the COVID-19 pandemic, we explored an empathy-driven prosociality relationship through an online task and questionnaires with a total of 1,190 participants. Chi-square test, independent samples t-tests, linear regression analysis and correlation analysis were used for the data characteristics comparisons between the pre-outbreak and outbreak peak era datasets. Mediation and moderation models were also computed.

Results

The present study found a population-based decline in empathy that ultimately affected prosocial willingness. Moreover, a distance effect in such a situation, consistent with the ripple effect, affected the way in which short-term anxiety during the outbreak influences empathic concern.

Conclusions

The empathic concern could have positively predicted prosocial willingness through the perception of the others' pain, while this relationship became less salient over the pandemic era. Measures are required to mitigate the adverse effects of empathy fatigue after the outbreak of COVID-19.

Background

The global health emergency, termed COVID-19 by the World Health Organization (WHO), has dramatically disturbed social order worldwide, casting a shadow over the lives of all. Whenever a major life hazard arises, mental resources such as empathy and patience may be damaged (Bavel et al., 2020). Individuals feel nervous and vicariously feel sorrow for all the suffering of infectors and medical staff during the contagious outbreak. It is likely that people will take a long time to combat the

pandemic according to the mainstream media (i.e., British Broadcasting Corporation). Emotional contact with people who are suffering and behaving prosocially in such a situation is essential. In particular, where collaboration is required to prevent large-scale malignant infections, taking into account the pain of others and intervening to avoid harming others is important (Grignoli et al., 2021). Research has shown for decades that empathy serves as a powerful motivator for prosocial behaviors (Dovidio & Banfield, 2015; Eisenberg & Fabes, 1991; Stocks et al., 2009). From ants' rescuing behavior (Nowbahari et al., 2009) to bats' reciprocal feeding, prosocial activity is observed throughout non-human species (Wascher et al., 2008). Decety et al. (2016) demonstrate the empathy-diven prosociality on conspecific across species. In this research, our objectives are to investigate whether the empathy and prosocial tendencies of people differ across two periods of time using two independent samples (pre-outbreak vs. outbreak peak era), and how internal factors (empathy and anxiety) and external influence (news, distance) involve in the population-based psychological changes.

Empathy and pain empathy

Empathy is seen as a social function that helps people understand the feelings or mental states of others (Van der Graaff et al., 2014). Two aspects have been indicated in the psychological framework of empathy: cognitive empathy and affective empathy. The division of empathy highlights basic empathy functions and the multiple forms of empathy an individual may encounter. Cognitive empathy defines how individuals perceive others' feelings and understand their experiences. On the other hand, affective empathy applies to independent and vicarious subjective reactions to others' feelings (Preston & De Waal, 2002; Shamay-Tsoory et al., 2009). There are two topics that scholars have reviewed about empathy, empathy for positive emotions or negative emotions. Pain Empathy is the mainstream of the large body of literature (Danziger et al., 2006; Decety et al., 2010; Klein & Gogolla, 2021). The ability to perceive and evaluate the pain of others and to consider others is specifically referred to as pain empathy (Fitzgibbon et al., 2010). In everyday life, pain empathy is an essential emotional reaction that helps people stay alert to dangerous circumstances and respond defensively (Danziger et al., 2006). Besides, in sustaining social ties and ensuring survival and growth, it also plays a crucial role (Majdandžić et al., 2016). Pain empathy may also be split into two main elements, following the general empathy structure: pain perception towards others and vicarious feeling of pain, correlated with the primary sensory circuit and the emotional circuit (Lamm et al., 2011). In addition to the behavioral predictor of empathy in tasks, the quantitative studies further examine how sub-dimensions of empathy are related to behavioral patterns by questionnaire-based assessment (Cronin, 2018; Pulos et al., 2004). Numerous tools have been designed to measure the intrinsic empathy structure (i.e., Interpersonal Reactivity Index, IRI; Basic Empathy Scale, BES) (Geng et al., 2012; Siu & Shek, 2005).

Prosocial actions and two facets of concern for pain

According to the empathy structure, both cognitive and affective aspects will trigger prosocial willingness and further care actions (Batson & Powell, 2003). The same regions in "pain matrix" brain networks, including the sensory and affective dimension of pain (Melzack, 1999), are activated when feeling

pain oneself and observing others' pain (Ploghaus, 1999). Fallon et al.(2020) identified the shared and unique networks for sensory and affective pain empathy. A much debated question is whether there is a possibility that the affective empathy ,to a significant degree, mediate empathy-driven altruism when empathy occurs (Piccinini & Schulz, 2019). Considering the relationship between different structures of empathy and prosocial behavior, the cognitive aspect of empathy ,compared to affective empathy, is potentially less conducive to promoting prosocial behavior (Santiesteban et al., 2020). In most population groups, the IRI is a practical assessment of multidimensional empathy (Davis, 1983). In particular, empathic concern (feelings of comfort, sympathy, and concern for those in distress) and perspective taking (the cognitive propensity to consider the psychological experience of others) of IRI are sensitive to the emotional and cognitive component of empathy respectively (Cronin, 2018). According to Batson's empathy-altruism hypothesis, empirical concern, which especially elicits an altruistic willingness to help (Batson, 2011). Via the two subscales of empathy, we intend to investigate the connection between the two facets of empathy and prosocial actions on our online pain recognition task.

The psychological status and behavioral patterns of individuals can have drastic variations in a specific period. People either develop an empathic approach (i.e., a motivated inclination to cooperate) or reinforce their empathic avoidance when disasters occur (i.e., act selfishly). Empathic motivation is goal-oriented, leading individuals to social interactions towards or away from them. In terms of specific categorization, Zaki et al. (2014) listed painful experiences, material cost as motivations to inhibit empathy. In order to foster empathy, positive emotions, social identity, and social expectations lead to the empathic approach. Given the severity of the current pandemics, questions are raised about these two opposite behavioral patterns, 1) which motivation is more prevalent in that arise during this period; 2) and what are potential reasons. Answers to these questions contribute to understanding the impact of acute events on mental health and new understanding.

Approach motivation: 'Catastrophe Compassion'

Zaki (2020) refers to 'catastrophe compassion' as an enhanced solidarity phenomenon during suffering. Prosocial behaviors are carried out during a life-threatening time to promote communication and encourage community members to survive emergencies such as food shortages and natural disasters together (Fehr & Fischbacher, 2003). The susceptibility and universality of the current COVID-19 impose the suffering on everyone, and prosocial actions are encouraged by such shared experience to help others more. It theoretically stems from a high collective sense of mutual identity as disaster survivors/defenders, and this malleable social identity is an influential source of prosocial actions (i.e., cooperation). Even without the common identity created in the pandemic, there is a notable phenomenon that most people value the painful suffering of others more than theirs (Crockett et al., 2014). A spontaneous urge to ease others' misery is produced as people feel the pain of others (Inagaki & Eisenberger, 2016; Roberts et al., 2014). To a certain degree, an act of altruistic action relieves unpleasant emotions shared with others (Singer, 2006) or also alleviates one's physical pain (Wang et al., 2020). However, it is unclear whether an enhanced approach to empathy can also arise during such a time, reflecting the willingness to relieve others' pain.

Avoidance motivation: 'Empathy Fatigue'

One component of social responsiveness is empathy-driven prosociality. An opposite probability will arise as the emotional resource runs out,' empathy exhaustion' (i.e., physical and emotional exhaustion and a profound decrease in empathy) (Joinson, 1992; Singer & Klimecki, 2014). Besides, people will turn to escape the cause of destructive emotions when a short, severe, or numbing and depressed reaction to an unfortunate circumstance happens (Figley, 2013). Highly transparent and timely information is possible in contrast to the SARS pandemic, primarily due to more sophisticated and varied information platforms. Though, mental state stability is threatened by diverse information and poses severe mental damage (Thompson et al., 2019). Public stability is maintained by positive slogans and straightforward legislative instructions, whereas negative news and rumors elicit emotional reactions such as sadness and fear (Batson et al., 1991). On social media, false news and disinformation about COVID-19 have proliferated extensively, with potentially harmful effects. Hence, news discriminability (identify the truth of news) is more critical under such periods (Apuke & Omar, 2021; Hoog & Verboon, 2020; van der Linden et al., 2020). People are highly nudged to consider news accuracy. Even though it is suitable for social order maintenance and clarity and immediacy guaranteed the right to be informed, bombarded information inevitably raises anxiety levels. Brooks et al. (2020) confirm a population-level mental health crisis, and emotions, especially sadness or depression and anxiety, play a significant role, which is thought to associate with helping activities negatively. These negative emotions are thought to suppress empathy-driven prosociality. How people interpret the degree to which they distinguish news credibility potentially modulates the relationship between anxiety and concern for others.

Wuhan was confirmed to be the initial hub of COVID-19 in China at the early outbreak level, which caught global attention and concern. There are two contrasting psychological influences on distance from the epicenter: 1) the ripple effect suggests that the impact of an unfortunate event decays gradually as ripples spread outward from the core (Slovic, 1987), while 2) the 'Psychological Typhoon Eye' effect (PTE) posits that the closer a resident lives to the epicenter of a devastated area, the less he/she is concerned/anxious about health and safety. Both theories stress the influence of the distance from the original outbreak center on human emotions, which enables us to pose opposite hypotheses about the COVID-19 outbreak's influencing the direction of empathy-driven prosocial conduct. That is, whether geographic proximity from Wuhan has an impact on facilitating or decreasing empathy when experiencing certain concern/anxiety levels. Given the importance of empathy and prosocial behavior for interpersonal interaction when disasters strike, the relationship between empathy and prosocial willingness (willingness to alleviate others' pain) may shed light on an adaptive psychological intervention policy. Moreover, several factors—such as news discriminability and anxiety—may tune-up empathy and empathy-driven prosociality.

Using an online study, we wonder if individuals are numb to the suffering of others. We hypothesize that (i) during the COVID-19 pandemic kept raging, empathy-driven prosocial willingness (willingness to alleviate others' pain) shifts comparing two samples; (ii) social influence such as news influences

empathy; (iii) anxiety during the outbreak influences empathy and prosocial willingness, and this effect varies based on the geographic distance to the initial outbreak hub (Wuhan).

Methods

Participants

Data for the first group (539 participants, 274 females, M_{age} = 28.43, SD = 7.84) was collected before the emerging infectious disease outbreak of COVID-19 (11/21/2019-11/23/2019), while data from the second group (570 participants, 366 females, M_{age} = 25.08, SD = 8.75) was collected during the peak period of public concern about COVID-19 (2/23/2020-2/24/2020). Conducted with G*power (Faul et al., 2007), a sensitivity power analysis indicated that a sample of 1090 participants provided 0.8 power to detect within-between interaction effect size of d = 0.138 with a = 0.05. We distributed the task and questionnaires via an online platform (wjx.cn). As Table 1 shows, the two groups were unevenly distributed in terms of age (t(1088)=6.64, P<0.001) and gender ($\chi2(df=1, N=1090)$ = 14.89, P<0.001) (More details in Fig. S1). Hence, we controlled for age and gender when comparing response variables across timepoints.

Video Stimuli

Twelve individuals in Beijing (six females and six males, M_{age} = 22.4, SD = 3.83) were recruited as actors for a video recording. An electric shock, a commonly known pain-induction method, is delivered to one finger of each actor in the video. All actors were then asked to express their true feelings about the pain from the electric shock or lie when they were not receiving a painful shock.

In the real pain scenarios (i.e., actors telling the truth), actors were asked to express and describe their genuine feelings of pain evoked by the electric shock. A standard answer outline was provided for each actor to ensure the descriptions of feelings were not heterogeneous. In the simulated pain scenarios (i.e., lying about the pain), actors were asked to pretend to be shocked and to describe those feigned feelings. Before their performance, the actors in the fake pain scenario were provided with videos of people getting real electric shocks and were asked to mimic people's responses in the videos. The stimuli consisted of 12 video clips portraying actors telling the truth or lying about the pain induced by electric shocks.

The research paradigm was approved by the China Academy of Science ethics committee, and all actors in the video recording gave informed consent to participate in the study.

Timeline and task components

The present research used a pain empathy task and three questionnaires as indicators to investigate the association between pain empathy and willingness to intervene and how the inner and external

influences of individuals contribute to it (Fig. 1).

Pain empathy task

Twelve video clips (six genuine expressions of feelings and six faked expressions of feelings) were presented to the participants in randomized order. After each video clip was played, participants judged whether the actor genuinely received an electric shock (choose '1' if it is true, and '2' if not true). Then, participants were asked to rate (from '1' = 'None' to '7' = 'very much') questions including 'how much pain do you think the person felt?' (pain-ratingother) followed by 'how much pain you feel when you are watching this video clip?' (vicarious experience). Moreover, 'to what extent are you willing to alleviate the pain of this person if possible?' (prosocial willingness). There was no time limit to provide feedback, and the next video was played after all ratings were completed. After watching and rating all 12 videos, participants completed a questionnaire session (Fig. S2).

Questionnaires session

Participants were asked to complete the Interpersonal Reactivity Index (IRI) at the end of the online task. IRI is a widely used scale to measure individual differences in empathy. It captures four different aspects: Perspective Taking, Fantasy, Empathic Concern, and Personal Distress (Davis, 1983). Participants rated how well each of the 28 statements in the IRI described their feelings on a scale ranging from "1 = totally disagree" to "5 = totally agree." The Cronbach's coefficient of the questionnaire in this study was 0.71.

Additional questionnaires were administered in the second study, given that it took place during the peak period of public concern about the coronavirus (Fig. 1). Specifically, the second online task included the State-Trait Anxiety Inventory (STAI) to capture both the participants' trait anxiety and state anxiety components (Spielberger, 2010). The Cronbach's coefficient of the questionnaire in this study was 0.94.

Moreover, an 18-item questionnaire about the emerging COVID-19 outbreak was included (Fig. 5, Fig. S6, S7, more details in supplementary materials).

Demographic information

After the questionnaire session, participants were asked to provide demographic information, including age and gender.

Statistical analysis

A total of 520 and 570 participants in the first and second datasets were included in the final analysis. Nineteen participants with missing demographic information (three participants did not provide age data,

and 16 participants did not provide distance information calculated by IP) were excluded from the final analysis.

Data were analyzed using statistical software, including SPSS 25.0 (IBM Corp., Armonk, NY) and R. Based on the research hypotheses, descriptive analyses were firstly conducted in SPSS. For the data characteristics comparisons between the two datasets (pre-outbreak vs. outbreak peak era), group comparisons of nominal variables were analyzed using the chi-square test. Independent samples t-tests were used to compare group differences (pre- vs. post-groups). Linear regression analysis and correlation analysis were performed in R. As for model construction, mediation and moderation models were computed with PROCESS 3.4 in SPSS, and R package MeMoBootR (https://github.com/doomlab/MeMoBootR) for the serial moderated mediation model.

Results

To explore what differences between the relationship of empathy and prosocial willingness before and during the COVID-19 outbreak, we first examined whether the pain judgment (true or faked) significantly affected three measurements: 1) perceived pain in others (pain-rating$_{other}$); 2) how much pain they feel when watching each video (vicarious experience); 3) and to what extent they are willing to alleviate the pain of others if possible (prosocial willingness) (Table S1; Fig. S4). However, to some extent, due to the limitations set by the experiment design, dichotomous judgments of true and false lack a measure of self-judgment confidence. That is to say, even if the judgments are made when the individual does not have absolute confidence, the participant may feel the pain and even intentionally help reduce the pain of the performer in the video (average score is above 1). Therefore, the judgement of experienced pain in the video clip was considered a possible confounding variable and we disassociated data that participants chose 'faked' option as a covariate, controlled in further model analyses.

Table 1. Sample characteristics

	pre (n = 520)	post (n =570)	t	P values
Demographic				
Age (years)	28.43 (7.84)	25.08 (8.74)	6.64	***
Sex (female)	53%	64%	$\chi^2 = 14.89$	——
IRI				
Perspective taking	24.14 (2.97)	23.43 (2.81)	4.06	***
Empathic Concern	25.05 (3.50)	24.56 (3.03)	2.48	*
Fantasy	25.54 (4.68)	23.98 (4.49)	2.03	*
Personal distress	23.53 (4.07)	24.14 (3.50)	-2.62	**
STAI				
State anxiety	——	40.31 (10.13)	——	——
Trait anxiety	——	43.89 (8.59)	——	——
Correct rate	0.51 (0.14)	0.50 (0.12)	9.97	**
Pain-rating$_{other}$	3.89 (0.049)	3.60 (0.041)	4.78	***
Vicarious experience	3.16 (0.045)	2.78 (0.042)	6.20	***
Prosocial willingness	3.73 (0.053)	3.50 (0.049)	3.16	**

Note: M (SEM), M: mean, SEM: standard error mean; *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$.

Task measurements in pre- and post-outbreak

Using the repeated measures anova, we first compared the differences in three measurements in our video task (pain-rating$_{other}$, vicarious experience and prosocial willingness) in pre- and post-outbreak datasets. There was a significant task measurements × time interaction ($F_{(1.71,3589.98)}$ = 4.674, $P < 0.000$, $\eta_p^2 = 0.002$), as well as main effects of task measurements and time (task measurements: $F_{(3.26,3543.98)}$ = 1032.9, $P < 0.000$, $\eta_p^2 = 0.07$; time: $F_{(1,2100)}$ = 104.52, $P < 0.000$, $\eta_p^2 = 0.015$). The results showed that pain-rating$_{other}$ (pre: M=3.89, SEM=0.05; post: M=3.60, SEM= 0.05; t=4.27, P<0.000), vicarious experience (pre: M=3.16, SEM= 0.05; post: M=2.78, SEM=0.042; t=6.20, P<0.000) and prosocial willingness (pre: M=3.73, SEM=0.05; post: M=3.50, SEM=0.05; t=3.16, P<0.01) demonstrated significantly population-based decrease in the outbreak era (Fig. 2a). Thus, as in the outbreak period, people were less willing to alleviate others' pain,as well as a reduced perception of other'pain and vicarious feeling.

Different aspects of empathy: pre- and post-outbreak

Since we were interested in the potential influence of the pandemic on the relationship between prosocial willingness and both the cognitive affective aspects of empathy. IRI, a robust measurements allowed us to examine the internal facets of empathy. Results showed that in the outbreak, a negative fluctuation was witnessed in most empathy-related dimensions measured by (IRI subscales × time: $F_{(2.78, 3021.93)}$ = 6.064, $P <$ 0.000, η_p^2 = 0.006; Fig. 2b), as well as main effect of IRI subscales($F_{(2.78, 3021.93)}$ = 21.83, $P <$ 0.001, η_p^2 = 0.02) and time ($F_{(1, 1086)}$ = 12.04, $P <$ 0.001, η_p^2 = 0.011). Except for personal distress (pre: M=23.53, SEM=0.18; post: M= 24.14, SEM= 0.15; t=-2.62, P<0.01), all other subscales' score significantly smaller in the post-outbreak: empathic concern (pre: M=25.05, SEM=0.15; post: M=24.56, SEM=0.13; t=2.48, P<0.05), fantasy (pre: M=24.54, SEM=0.21; post: M=23.98, SEM=0.19; t=2.03, P<0.05), and perspective-taking (pre: M=24.14, SEM=0.13; post: M=23.43, SEM=0.12; t=4.06, $P <$ 0.001).

The results above showed that pain-rating$_{other}$, empathic concern, perspective taking, fantasy, and prosocial willingness showed a decline fluctuation during the emerging outbreak than the dataset before the outbreak. However, we were still not clear how the internal construct of empathy-related to our task measurements. Whether a more significant reduction in willingness to help others correlated to individuals' empathy dispositions? Was this bond further exaggerated (approach motivation) or decreased (avoidance motivation) during the outbreak?

Empathy-driven prosocial willingness

We further investigated whether our task measurements would mediate the relationship between individual differences and prosocial willingness by establishing three mediation models with empathic concern (empathy, perspective-taking, and fantasy) as a predictor, pain-rating$_{other}$ as a mediator, and prosocial willingness as the dependent variable (model 14 in Process). Data were standardized to analyze moderation and mediation models while using PROCESS in SPSS (Hayes, 2012).

Results showed a significant mediation effect of pain-rating$_{other}$ for empathic concern and perspective-taking, but not for fantasy (vicarious experience did not demonstrate a mediation effect, since the vicarious experience was not predictive by empathic concern, 95%CI of β: [-0.016, 0.054]). Empathic concern positively predicted prosocial willingness (β=0.052, $t_{(2095)}$=3.16, P<0.000; path C') and pain-rating$_{other}$ in a positive manner (β=0.057, $t_{(2098)}$=3.49, P<0.001; path A). Furthermore, pain-rating$_{other}$ robustly predicted prosocial willingness (β=0.62, $t_{(2095)}$=21.97, P<0.001; path B) (Fig. 3a). Perspective taking positively predicted prosocial willingness (β=0.096, $t_{(2095)}$=5.85, P<0.001; path C'), and pain-rating$_{other}$ as well (β=0.043, $t_{(2098)}$=2.64, P=0.008; path A). Similarly, perspective-taking significantly predicted prosocial willingness (β=0.62, $t_{(2095)}$=22.07, P<0.001; path B) (Fig. 3b). Finally, fantasy did not predict pain-rating$_{other}$ (β=0.03, $t_{(2098)}$=1.96, P=0.05; path A) and prosocial willingness (β=0.01, $t_{(2095)}$=0.69, P=0.49).

Our results indicated that only pain-rating$_{other}$ could mediate the predictive relationship from empathic concern/perspective-taking to prosocial willingness, but not from fantasy. Meanwhile, in contrast to

perspective taking, empathic concern tended to be more effective in predicting pain ratings of others' pain. We further included a binary variable of time (pre- and post-outbreak) as a moderator to examine whether the outbreak era would have a moderation effect. These results showed that the moderation effect on pain-rating$_{other}$, predicting prosocial willingness (β=-0.089, P=0.012<0.05, 95% CI: [-0.15,-0.02], path B), thus suggesting that the predictive effect of empathic concern empathy-related constructs to prosocial willingness decreased during the outbreak (Fig. 4a, b).

Anxiety and distance from the outbreak epicenter

Emotions play a major role in a population-level mental health crisis, among which, anxiety is considered an influential factor in empathy and prosocial behaviors. Previous studies have also demonstrated that social events influence everyone's mentality, and in times of emergency, the demand for information rises significantly, but rumors are also prevalent at this moment. To a significant extent, rumors impact the relationship between emotion and cognition.

We also want to examine how the experience of ambiguity in international events by people, especially the uncertainty of news, influences the components related to empathy. A symbiotic connection exists between the media and culture. The development of improved social communication is the birth of a medium. Excessive exposure to untrue information increases people's anxiety about the validity of news and indifference or uncertainty against the news fed to our sight. We attempted to examine how news authenticity discriminability induced anxiety-affected empathic concern. "News authenticity discriminability" was measured by one question —— 'I can accurately distinguish true and false messages related to this disease.', and a high score represents higher confidence in discriminating news authenticity (Fig. 5b). The State-Trait Anxiety Inventory (STAI) was used to evaluate post-outbreak anxiety levels (Table 1), along with some direct questions about how people felt during the outbreak in terms of anxiety, depression, and fear (see more in supplementary materials).

News discriminability moderated how state anxiety negatively predicted empathic concern (STAI subscale). State anxiety in this model predicted empathy (β=-0.17, $t_{(1119)}$=-5.62, P<0.001). News discriminability did not significantly predict empathic concern ($t_{(1119)}$=0.02, P=0.98). The more anxious people felt, the less empathy they displayed. The interaction of news discriminability and state anxiety was significant (β=-0.07, $t_{(1119)}$=-2.38, P=0.02). In the post-outbreak period, people became confused about overwhelming news, which negatively influenced the empathic concern (Fig. 5a, 5b; Table S2).

"The ripple effect" in data gathered from this study

In addition to the self-report of faked news discriminability that is a subjective predictor influencing the emotional-cognitive connection, we wanted to examine two well-established theories (PTE effect vs. the ripple effect). That is how geographic proximity influences the direction of empathy-driven prosocial conduct undergoing emergency. To test how anxiety affects prosocial willingness during the outbreak era (Dataset 2 only) in terms of distance, a moderation model (model 1 in PROCESS) was used. The variable 'distance from Wuhan' is a binary variable, defined by the distance calculated by the IP address (see

supplementary materials Method) and divided into two types (near/far). There was no indication that distance affected the association between pain-rating$_{other}$ and prosocial willingness (Fig. S6).

We established a serial, two-part mediation model (model 6 in PROCESS). The results showed that anxiety could influence prosocial willingness through empathic concern and pain-rating$_{other}$ (Fig. 3c). First, there was no clear evidence showing that state anxiety directly correlates with the prosocial willingness (β=-0.03, $t_{(1119)}$=-0.964, P=0.335, path C). The direct effect of state anxiety, however, seemed to be suppressed by the indirect path in which prosocial willingness was predictive by state anxiety (β<0.01, $t_{(1117)}$=0.07, P=0.944, path C'). Along the indirect path, the state anxiety successfully predicted empathic concern (β=-0.17, $t_{(1119)}$=-5.78, P<0.000, path A1). Meanwhile, empathic concern predicted pain-rating$_{other}$ (β =0.08, $t_{(1118)}$=3.33, P<0.001, path DA1) and overall prosocial willingness (β=0.06, $t_{(1117)}$=2.595, P < 0.001, path B1). As in previously established models in our results, pain-rating$_{other}$ robustly predicted overall prosocial willingness in our Dataset 2 (β=0.52, $t_{(1117)}$=0.52, P<0.001, path B2) (Fig. 3c).

Finally, we explored the effect of distance by calculating each participant's distance from the disease epicenter based on IP address and divided into two groups (near/far) by the mean of the calculated distance. The interaction between distance from Wuhan and state anxiety was significant (β=0.17, $t_{(1117)}$=2.74, P<0.01), suggesting a moderation effect of distance in the serial two-part mediation model (Fig. 3c). Notably, that distance moderated the influence of anxiety on the empathic concern and further affected prosocial willingness.

Discussion

The COVID-19 has intensified mental health problems and prompted a political commitment to interventions. The purpose of this research was to examine the impact of an ongoing infectious outbreak on the prosociality of individuals and further explored the underlying mechanisms on potential factors from internal and external aspects, including internal (trait and anxious emotion), and external factors (news and participants' distance to the epicenter). A population-based reduction in empathy was reported by a two-group contrast that eventually impaired prosocial willingness. Interventions are expected to mitigate the adverse effects of mental health issues induced by empathic fatigue due to the outbreak of COVID-19.

Empathy-driven prosociality during the COVID-19

Our results showed a successful induction of empathy in this study. The empathic concern was significantly associated with the perception of the pain level of others, and pain ratings about others also predicted how much they would like to relieve the pain of others. Thus, data in this research first extended previous research findings by demonstrating the general empathy-driven prosocial disposition (Masten et al., 2011; Roberts et al., 2014). In addition, data obtained in two time periods enabled us to explore the

relationship between pain-rating$_{other}$ and prosocial willingness before and during the outbreak. To explore the contrary assumptions of human behavior in this infectious outbreak (catastrophic convergence vs. empathic fatigue), instead of an improved approach motivation for empathic concern, less prosocial inclination has been found in this research. From an evolutionary point of view, when some are at a disadvantage (i.e., physical discomfort and emotional setbacks), a motivation to provide assistance is generated for both the victim and the collective benefit (Trivers, 1971), referred to it as the 'catastrophe convergence' (Majdandžić et al., 2016). Although in the case of how people are able to relieve the pain of others, we speculated that 'collateral damage from trauma' gives a reason as to the prosocial inclination decline. The injury of others who do not personally encounter misfortune may still establish a related emotional experience by witnessing the suffering experience of others (Gallese, 2003), which encourages a deep motivation to avoid perceiving the suffering of others (Cameron et al., 2019). To a certain extent, we respond to individuals on the basis of how they make us feel and how we hope we would experience if we support them (Jhangiani et al., 2014). Given the influence of the perception of the sensory experience of others on the motivation to act prosocially, pain-rating$_{other}$ (how people perceive others' pain) decreased during the outbreak comparing two independent datasets. Also, we found a consistent trend in the willingness to behave prosocially. Evidence in this study may shed light on how this population-based perception reduction happened, in which a different tendency of perspective taking between pre- and during the outbreak phase was observed. Since perspective taking is closely connected to feeling what others feel, it is not difficult to understand being more self-centered and not viewing things from the perspective of others will lead to less painful evaluations about others (Epley et al., 2006). This speculation was confirmed by our second sample gathered during the pandemic as a population-based decline was found in perspective taking. It is a strategy that decreases other-oriented anxiety and preserves inner harmony on account of the high energy cost associated with empathy (Cameron et al., 2019). This statement might explain why empathy avoidance may be a preferable choice in a crisis as people have only limited inner resources. Understandably, one no longer appears capable of giving assistance or moral help to another while one's own life is at stake (Volz et al., 2017).

Generally, the cognitive component of empathy (perspective taking), relative to affective empathy (empathic concern), is theoretically less beneficial to prosocial promotion (Lamm et al., 2007; Litvack-Miller et al., 1997). Given the mechanism of two subcomponents in empathy-related to prosocial behavior, depending on our online pain recognition task, we aimed to examine the relationship between the aspects of empathy and prosocial behavior through the two scales. In comparison to perspective taking, empathic concern, meanwhile, appeared to be more efficient in predicting pain ratings others' pain, which is following the conclusion that affection overrides cognition in the prediction of prosociality (Nummenmaa et al., 2008). Surprisingly, however, in our supplementary dataset 3, measured after unblocking in China, a recovery pattern was identified (Fig. S9). However, empathy concern continued to decrease across the three time points, indicating different changes on cognitive empathy and affective empathy after unblocking.

The external stimuli are positively correlated with internal psychological structures measured by valid instruments. Individual differences in empathic concern have an essential impact on the behavioral propensity (Decety et al., 2016). We found how the three variables (pain-rating$_{other}$, empathic concern and prosocial willingness) associated. Specifically, we were primarily concerned with how empathic concern affected prosocial behavior and the role of pain-rating$_{other}$ in the process. As expected, a robust moderation model was established when the effect of COVID-19 was considered (the comparison between two-time stages). We found that empathic concern could predict prosocial willingness both directly and indirectly through pain-rating$_{other}$, which varied from pre- and post-outbreak. In general, the empathic concern could affect prosocial patterns, as it is often so closely related to care for others (Cronin, 2018). This mechanism has been mediated by how the pain of others is perceived. Our findings may reflect a typical pattern of empathic regulation that decreases the perception of pain and empathy to attain inner harmony (Bandura, 2016). For example, professionals (i.e., surgeons) exposed to an empathic environment for a long time may reduce their empathic responses by adjusting their perceptions on the moral level (Decety et al., 2010).

The effects of anxiety, news, and distance

The findings of the mediation model with empathy constructs, emotional state, and distance to the epicenter might explain deviations in pain empathy or prosocial tendency in our collected data during the outbreak (Dataset 2). The strength of empathic concern was greatly hindered by the degree of anxiety, the disparity in the distance (between close and far regions) and the levels of news discriminability. One of the most apparent impacts of the COVID-19 pandemic is that it induces stress and anxiety, which is disruptive. Gallese (2003) has suggested that anxiety has been reported to inhibit the neural underpinnings (i.e., the mirror neuron system) of empathy. We expected that people's empathy would be affected by anxiety. Results indicated that people who currently felt anxious (state anxiety) and were more confused about the news's authenticity showed a lower level of empathy than those who felt less anxious and confused. Interestingly, state anxiety can also be regulated by self-reported — 'how they tell apart the true or faked property of news validity', in addition, to directly influencing empathic concern. Therefore, it is necessary for relevant departments to pay more attention to information dissemination methods, to reduce the adverse effects of excessive information exposure on mental health. The wording of the news to report good news and bad news can be under the condition of without changing the original information. For example, the description framework of information, such as the numeric information (when reporting survival rates or mortality proportion, overall number in the investigation should be supplementary) and graphs, are more conducive to smooth the emotional states and relevant information immediately to the public (Rodrigues & Xu, 2020; van der Linden et al., 2020).

To address which distance effect (PTE effect vs. the ripple effect) is more prevalent or salient in the gathered data, the ripple effect is finally demonstrated in our data. An infectious pandemic frustrated people near the epicenter more than people in regions farther away. State anxiety affected empathic concern negatively, and the relationship could be moderated by distance (people near the epicenter were

more influenced by COVID-19). The empathic concern in people near the epicenter became smaller as state anxiety increased, while people outside the epicenter did not change significantly. The customized COVID-19 related questions (Table S2; Fig. S6, S7, S8) suggested that people in the regions near Wuhan reported that patients in Wuhan faced more stigmatization and rejection from others. In the social psychology literature, stigma from others has become a significant theme (Lee et al., 2005), and even after the pandemic is under control, it will be a long-lasting problem. Therefore, people in the area near Wuhan may experience heavier psychological stress relative to the regions far from the epicenter. Interestingly, after the lifting of Wuhan's quarantine, the modulation influence of geographic distance vanished (Fig. S10), indicating a temporary link between state anxiety and empathic concern due to the terrible spreading disease. Our third dataset (i.e., data obtained after the unblocking) showed that state anxiety decreased after Wuhan's lockdown, but we should consider cautiously attributing this to the improved pandemic condition. For example, some individuals will return to everyday life, while others will likely experience unemployment, resulting in stress complexity following the lockout (O'Flynn, 2020).

Whenever a public emergency occurs, misinformation circulates throughout daily life (Leng et al., 2020). In reality, media accounts may tend to highlight this sort of data to distract focus (Thompson et al., 2019). Empathy is associated with fundamental cognitive processes such as attention (Zaki et al., 2016) and this may suggest why our research has not proved the convergence of catastrophes. When bombarded by unpredictable news about problematic issues such as earthquakes, disease, and homelessness, people can feel empathy at first, accompanied by symptoms comparable to exhaustion of empathy, such as depression and anxiety, to differing degrees (Kinnick et al., 1996). Under the current barrage of information, our study's findings seem to be more supportive of the presence of empathy fatigue, which can protect people from mental resource burnout (Figley, 2013). Besides, if empathy produces motivation, however, there is no practical way to help, people will inevitably feel more anxious and miserable, which will further impact prosociality (Back & Arnold, 2014).

Limitations

The present study has several limitations. First, data were obtained from self-report using two independent samples that were not fully randomly distributed. Second, participants were experiencing a pandemic lockdown during the second assessment period, but we did not consider the restriction as a potential factor. Third, due to the anonymous nature of the data collection, we could not pair individuals between the two time intervals. Moreover, using a dichotomous distance variable precluded exploration of the possible influence of a continuous geographical position.

Importantly, this paper contributes to crucial debates concerning mental health during the outbreak and provides several potential explanations for the relationship between empathy and prosocial willingness before and during the COVID-19 outbreak. A full exploration of the underlying mechanics from internal and external influences about the relationship between empathy and prosociality is present. Briefly, this study has identified that empathic concern could positively predict prosocial willingness through the perception of others' pain. Over the pandemic era, however, this relationship became less salient. The

short-term anxiety during the outbreak affected empathic concern and was mediated by geographical distance from Wuhan. We discuss the contribution of the affective and cognitive structures of empathy to the prosocial willingness. An empathetic avoidance tendency was observed in the experience of COVID-19, which verified the theory of empathic fatigue. In addition, as the psychological effects of distance, we validated the ripple effect of disasters and uncovered the influence of social news on the relationship between anxiety and empathy in our second dataset. The preconditions for intervention rely on the comprehension of psychological states and the underlying mechanisms, which our research is useful in expanding the understanding of emotion and cognition association in prosociality during the outbreak.

Empathy enables us to engage in more prosocial behavior. Anxiety, fake news, and uncertainty reach oneself, however, dampen the drive of an approach to acting prosocially. While kindness is desirable, from avoiding mental burnout, the adjustment in how to experience the feeling of another by itself is pragmatic. Particularly for care workers who suffer overconsumption of their empathy and thus become even more depressed because of direct and frequent interaction with the suffering of others (McAlonan et al., 2007). Future approaches that seek to rejuvenate the empathic potential of individuals, disperse anxiety, and help control the feelings of people during public health emergencies are deserving of consideration.

Abbreviations

Not applicable

Declarations

Ethics approval and consent to participate

The experimental protocol of this study was approved by the ethical review committee of Institute of Psychology, Chinese Academy of Sciences. Informed consent was obtained from all individual participants included in the study. The risk of the participants in stimuli material was relatively low and the individual electric shock level was calibrated to a tolerable level before the formal data collection. At the end of the experiment, the subjects verbally reported no discomfort.

Consent for publication

According to the scientific research standard of the committee of Institute of Psychology, Chinese Academy of Sciences, all participants aged above 18 years have signed a informed consent for the experiment design and the publication by themselves, and no participants aged under 18 years in the human material of this research.

Availability of data and material

The datasets supporting the conclusions of this article are available in the OSF repository, [https://osf.io/9bgkt/].

Competing interests

The authors declare no conflict of interest.

Funding

Authors' contributions

H.W. conceived the presented topic. S.C. carried out the analysis, led the manuscript writing and collected data with H.X and W.Y. H.Q prepared the experimental materials and collected the data. Q.Y, X.L. and H.W. supervised the writing process. All the authors contributed to the final manuscript.

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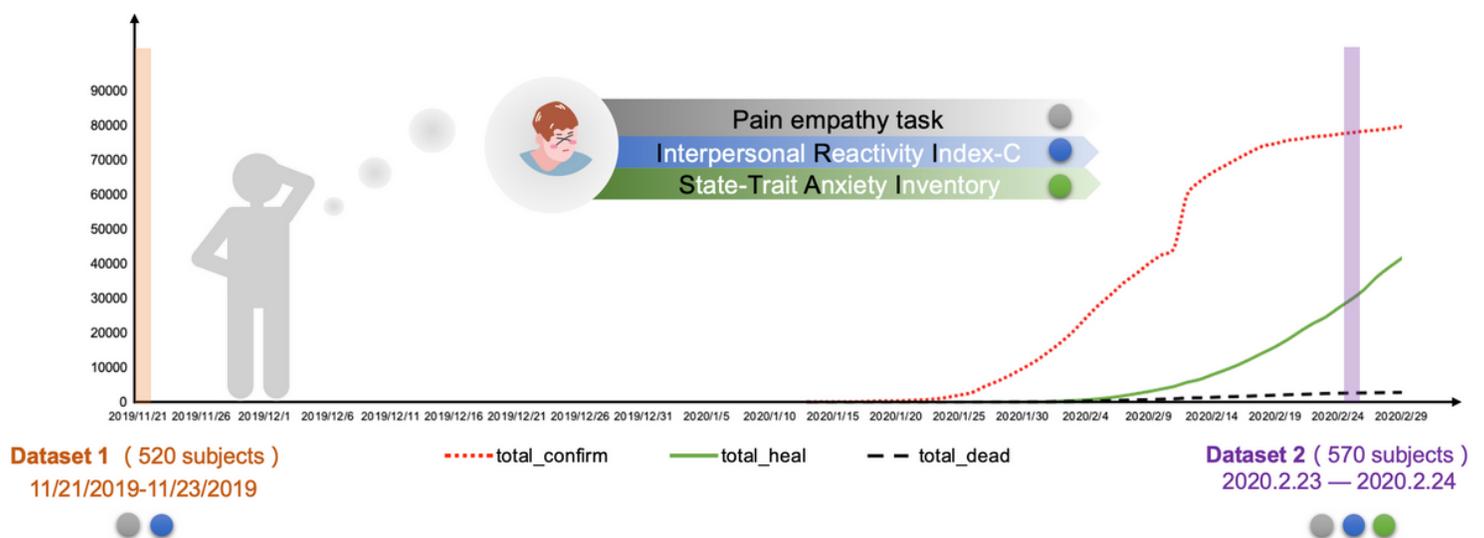
Figures

Figure 1

Experiment Timeline and task components red dot line represents a total number of confirmatory cases in China; green line illustrates a total number of cured cases in China; and black dot line represents dead

cases in China; Orange region means the timestamp that we conducted our first survey; and the purple region means the timestamp of our second survey.
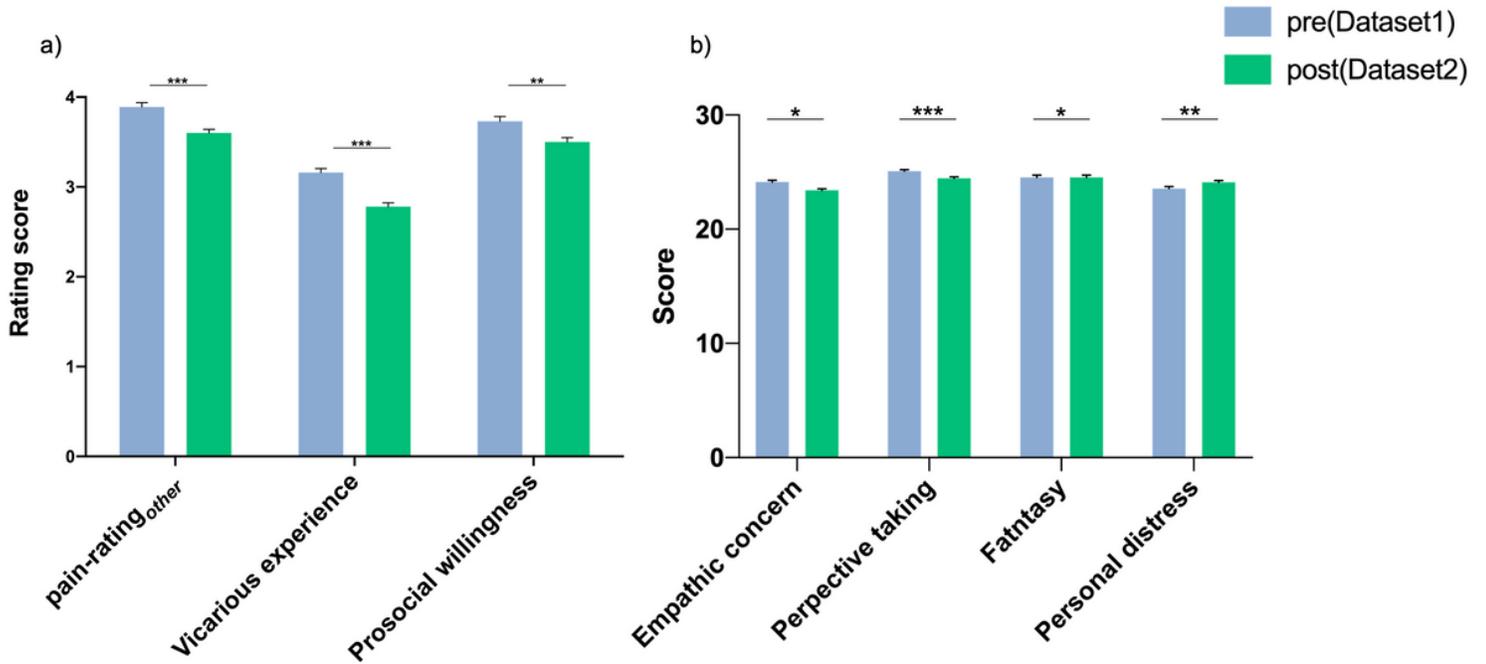

Figure 2

Measurements of the pre- and post-datasets. a, results of the online video task measurements in pre- and post- dataset; b, Scores of different aspects of empathy measure by IRI in pre- and post- dataset.
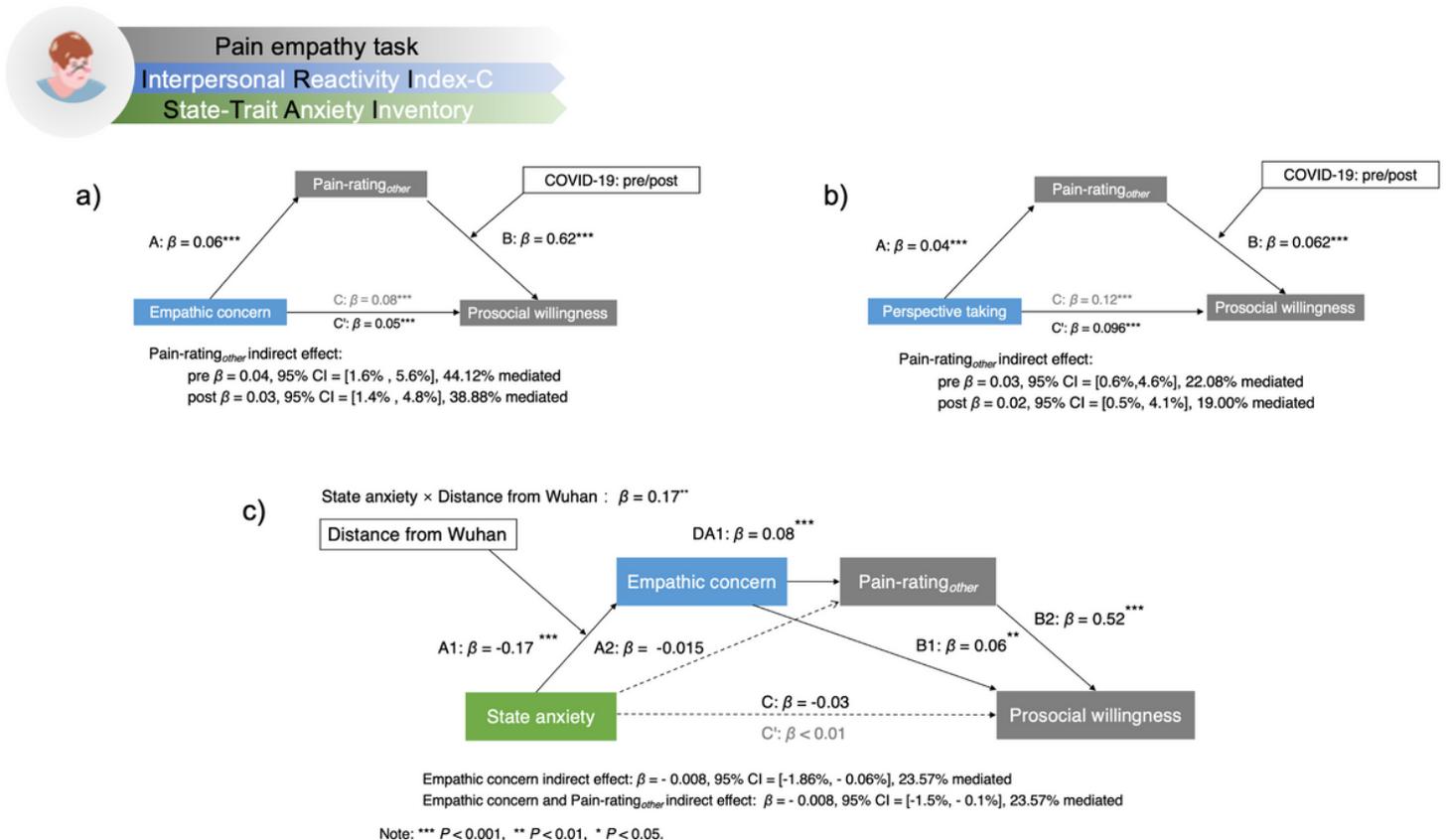

Note: *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$.

Figure 3

The mediation models and serial two-part mediation model (during pandemic). a, time functioned as a moderator in the path B (pain-rating$_{other}$ to prosocial willingness) (pre: 95% CI=[1.5%,5.6%], 44.12% mediated; post: 95% CI=[1.2%, 4.8%], 38.88% mediated). b, time still had a moderation effect in the path B (pre, 95% CI=[0.6%, 4.6%], 22.08% mediated; post, 95% CI=[0.5%, 4.1%], 19.00% mediated). c, a serial mediation model of state anxiety predicting prosocial willingness during pandmic.
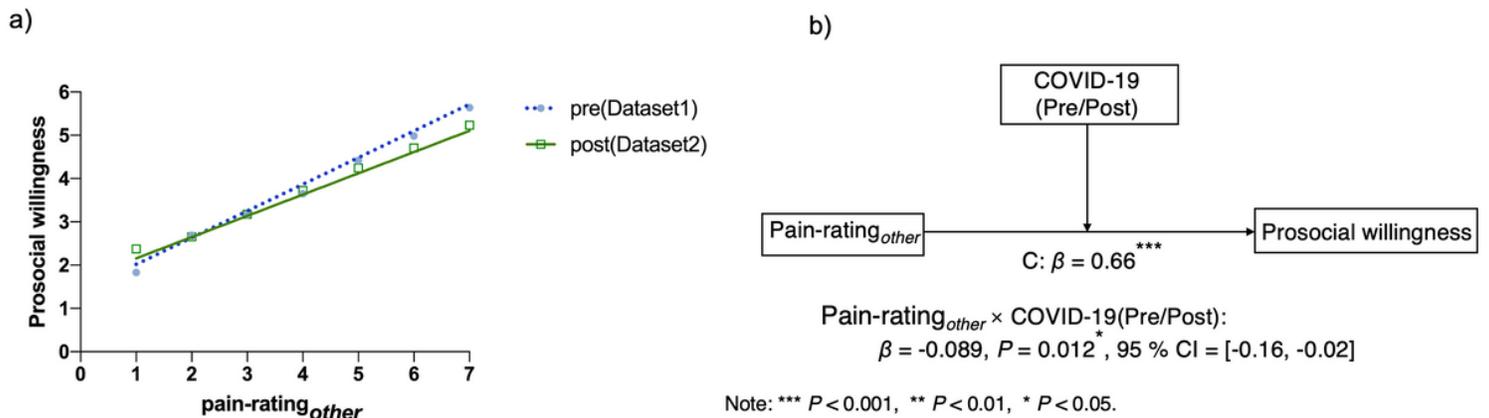
a)

b)

COVID-19 (Pre/Post)

Pain-rating$_{other}$ → Prosocial willingness

C: $\beta = 0.66$***

Pain-rating$_{other}$ × COVID-19(Pre/Post):
$\beta = -0.089$, $P = 0.012$*, 95 % CI = [-0.16, -0.02]

Note: *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$.

Figure 4

The moderation model. a, The prediect effect of pain-rating of others in the videos. b, The effect of how pain-rating of others predicting prosocial willingness is modulated by time.

a)

News discriminability

State anxiety → Empathic concern

C: $\beta = -0.17$***

State anxiety × Distance interaction:
$\beta = -0.07$*, 95% CI: [-0.12, -0.01],

Note: *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$.

b)

Dataset 2
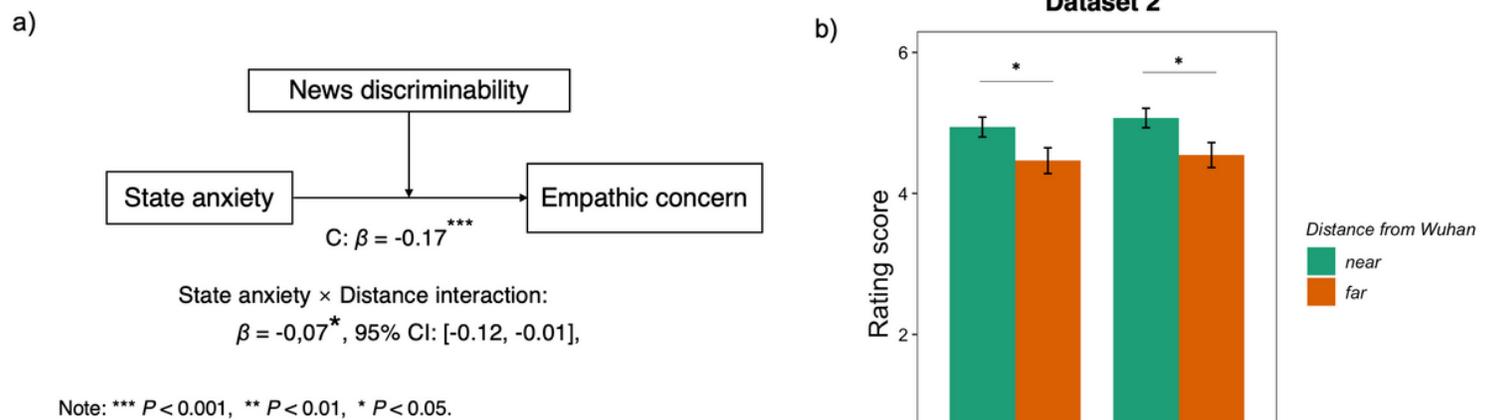
Distance from Wuhan
near
far

Figure 5

A moderation effect of news discriminability. a, How state anxiety measured by STAI predicts empathic concern measured by IRI was influenced by self-reported news discriminability. b, News discriminability measured by 'I can accurately distinguish true and false messages related to this disease.', and a high score represents higher confidence in discriminating news authenticity. Social exclusion score was measured by "Patients with COVID-19 have been socially discriminated during the disease outbreak", and

a high score represents higher social exclusion towards COVID-19 patients that was perceived by the sample in dataset 2 (post-outbreak).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- supplementarymaterials20210607.pdf