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Priming close social contact protective behaviors enhances protective social norms perceptions, protection views, and self-protective behaviors during disasters

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ABSTRACT

Many people do not make choices that minimize risk in the face of health and environmental threats. Using pre-registered analyses, we tested whether a risk communication that primed perceptions about health-protective preparation and behavior of close social contacts promoted protection views and protective behaviors. From December 10–24, 2020, we fielded a 2 (threat vignette: wildfire or COVID-19) x 3 (social contact prime: control, inaction, or action) experiment to a representative sample of 1,108 California residents facing increased COVID-19 cases/deaths, who had recently experienced the most destructive wildfire season in California history. Outcome variables were protection views and protective behavior (i.e., information seeking). Across threat conditions, stronger social norms, efficacy, and worry predicted greater protection views and some protective behaviors. Priming social-contact action resulted in greater COVID-19 information-seeking compared to the control. In the wildfire smoke condition, priming social contact action and inaction increased perceived protective behavior social norms compared to the control; social norms partially mediated the relationships of priming with protection views and protective behaviors; and having existing mask supplies enhanced the relationship between priming inaction and greater protection views compared to priming action or the control. Findings highlight the importance of social influence for health protection views and protective behaviors. Communications enhancing social norms that are sensitive to resource contexts may help promote protective behaviors.

Mitigating the deleterious consequences of exposure to health threats requires effective public policies as well as substantial individual-level personal choices that minimize exposure [1]. Yet in the United States, many people do not take protective action in the face of threats such as natural disasters and infectious disease outbreaks [2]. Risk communications that clearly explain a threat and ways to reduce risk may help people understand the nature of health threats, recognize actions that reduce their exposure, and motivate the adoption of protective behaviors [3]. Evidence suggests that the effectiveness of risk communications to motivate protective behavior varies due to a combination of psychosocial (e.g., social norms) and situational (e.g., threat type) factors [4]. Hence, it is imperative that risk communications are informed by these factors and evaluated for effectiveness in encouraging protective behaviors in settings with higher ecological validity (e.g., field studies with diverse, representative samples). Herein we test the

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effectiveness of a social priming intervention to promote greater protection views and protective behaviors using a probability-based sample of Californians who, at the time of data collection (December 2020), faced a staggering increase of COVID-19 cases and deaths. Concurrently, a few months prior to the study, the state had recently suffered from one of the most devastating and destructive wildfire seasons in recorded history. Recent assessments of surveys with nonrepresentative samples demonstrate critical flaws including inflated point estimates [5] and nonrepresentative surveys conducted during COVID-19 were particularly problematic as they tended to exclude underrepresented minorities and low-income groups [6]. Thus, experimental studies with representative samples, especially in ecologically valid settings, evaluating interventions are essential.

Building from theories of social contagion [7], a growing body of evidence suggests that perceptions about the behaviors of close social contacts (i.e., family, friends, and acquaintances) may influence behaviors. For example, recent studies suggest that perceptions about close social contact voting behavior may play a more important role in ones' own behavior than ones' own stated voting intention [8]. Similarly, social contact perceptions help predict vaccination behaviors [9,10]. These findings suggest that priming people to think about their close social contacts' protective behaviors in a proactive way may help enhance protective behaviors in response to health threats, with implications for designing more effective risk communications.

1. Case study: wildfire smoke and COVID-19

The COVID-19 pandemic has threatened the lives and livelihoods of billions of people worldwide [11,12]. Reports suggest that as COVID-19 becomes endemic, people may need to practice social distancing and wear masks for years to come – at least in some settings – to keep the proportion of people with COVID-19 manageable for healthcare systems [13], minimize infections until vaccines and effective treatment are widely available globally [14,15], and deal with the ongoing threat of emerging variants. Concurrently, billions are exposed annually to historically unprecedented environmental extremes. These extremes are predicted to increase this century and include weather and climate events such as wildfires that are in the very upper or lower range of historic observations (e.g., record temperatures), greater in number, and/or with higher adverse impacts than are typically observed [16]. Extreme wildfire events have recently impacted the western United States, southeastern Australia, and the Brazilian Amazon [17,18]. As a result, exposure to wildfire smoke [19–22] is a growing problem that results in immediate (coughing, wheezing, headaches) [23] and long-term (asthma, cardiovascular events, stress, and trauma) [23–25] health consequences [26–29]. Indeed, deaths [23] in the U.S. from wildfire smoke could increase from 15,000 per year today to 44,000 per year by the end of the century due to projected increases in wildfire activity as more people are exposed to smoke [30]. This activity is expected to increase because of drier and hotter conditions [19,20], as well as because more people are living at the wildland-urban interface [31,32].

Taken together, this literature suggests developing effective risk communications is crucial in many regions that face compounding and increasing threats. It is particularly important in cases where threats are unfamiliar or are complex disasters where people must deal with multiple threats at once. For example, California experienced an unprecedented, destructive 2020 wildfire season where more than 4.2 million acres of the state burned, 33 people perished, more than 10,000 structures were destroyed [33], and millions were exposed to long periods of unhealthy air pollution. Tens of thousands of residents had to evacuate their homes in August 2020 after dry lightning storms ignited 100s of fires in Northern California. These individuals had to make hard decisions about where to go and how to shelter safely during the COVID-19 pandemic. Effective risk communications must recognize that people do not make decisions about whether to adopt health protective behaviors in isolation of other risks, their personal circumstances, and their social contexts.

1.1. Protective perceptions: social norms, efficacy, risk perceptions, and worry

Prominent theories such as the Protective Motivation Theory [34], Health Belief Model [35], Theory of Planned Behavior [36], Protective Action Decision Model [37], and Extended Parallel Process Model [38] suggest that psychosocial factors (e.g., protective behavioral social norms, efficacy regarding protective behaviors, and the perceptions of risk that people hold regarding a threat) help shape protective views and behaviors. For example, Protective Motivation Theory suggests that individuals high in risk perceptions and efficacy would practice more protective behaviors than those low in risk perceptions and efficacy [34].

Social norms are the rules tacitly accepted by members of a group that shape how members behave [39]. Three social norms, descriptive ("what others are doing") [39], subjective ("what others approve of me doing") [36], and injunctive ("what I ought to do") [39], have been widely researched in the literature. These norms – and people's perception of them [40] – guide views and behaviors [41,42], including those related to health [43,44]. For example, in the context of flooding, one study found stronger subjective norms were associated with the purchase of flood insurance [45]. Another study found that stronger descriptive and injunctive norms were associated with greater mask use intentions during air pollution events [46], relevant to wildfire smoke.

Generally, both self- and response-efficacy have been associated with increased performance of protective behaviors. According to Bandura [47,48], perceived self-efficacy is the belief that a person has the capacity to exert influence on events that happen in their lives. A strong sense of perceived self-efficacy is associated with greater resilience in the face of threats, and greater self-assurance that challenges can be effectively managed. Response-efficacy is the view that the options available to an individual are appropriate for meeting that threat [3,49–51] and, when coupled with a strong sense of perceived self-efficacy, that an individual can actually use those options to successfully reduce consequences of the threat [49]. A survey of 521 respondents impacted by Hurricane Matthew [3] found greater perceived self-efficacy was associated with greater engagement in protective behaviors such as preparing for the hurricane and evacuating. Similarly, in a study [52] of 761 Dutch residents, high levels of response- and self-efficacy were associated with greater flood protective behaviors, such as information-seeking.

Risk perceptions are also associated with engaging in protective behaviors [53–55] across a range of hazards. Generally, risk is defined as a combination of the likelihood and severity of an event such as a wildfire or global pandemic occurring. Risk perceptions

are subjective judgments that include both probability of harm (severity) and future likelihood (susceptibility). A recent nationally representative sample of 6,684 Americans found that risk perceptions were positively associated with frequency of implementing protective behaviors such as hand washing and social distancing in response to COVID-19 [56]. More specifically, in a distinct nationally representative sample of 6,514 Americans, both severity and susceptibility judgments were positively associated with performance of health protective behaviors in response to COVID-19 [53]. Other studies have found that higher risk perceptions were associated with the adoption of protective behaviors in the context of sea level rise [57] and hurricanes [58].

Emotions such as worry are increasingly recognized as being important for predicting behaviors, including those related to health [59–61]. Worry, defined as "preoccupation with thoughts about uncertain and unpleasant events" [62] (p. 85) is associated with a negative affective state [63]. This emotional response is typically distinct from risk perceptions, viewed as cognitive processes, although they often do share a reciprocal relationship [60]. Sweeny and Dooley (2017) [60] describe three reasons why worry motivates health protective behaviors: it communicates the seriousness of an issue, it keeps the issue front of mind, and it results in efforts to actively deal with or cope with the issue. For example, a survey of 2,174 Australian residents recruited through social media posts found increased worry about COVID-19 was associated with greater protective behaviors such as social distancing and hygiene practices, and greater intent to be vaccinated against COVID-19 [64].

1.2. Priming: close social contacts protective behaviors

People are influenced by direct observation of the actions and attitudes of people they are in contact with, as well as what they *perceive* their close social contacts are thinking and doing [65–68]. For example, in the evacuation literature, observing neighbors evacuating from a threat provides a vivid cue for individuals to do likewise [69–71]. Recent research found that these perceptions are fairly accurate, and that they are predictive of an individual's own behavior across a range of domain areas [8]. Galesic et al. (2018) [66] found that in the 2016 United States and 2017 French presidential elections, the perception of the voting behaviors of one's close social contacts predicted one's actual voting behavior better than one's own self-reported pre-election voting intentions. Relatedly, Bruine de Bruin et al. (2019) [9] found people who perceived that those in their close social contacts had received a flu vaccine were more likely to have gotten a vaccine that flu season and were more likely to get vaccinated in the following flu season.

1.3. Context: existing protective supplies

Priming people to consider close social contacts' protective behaviors may influence protective views and behaviors [72–74], however the extent to which people have already taken steps to protect themselves may matter more [3]. For example, people who are primed to think of close social contacts taking protective action such as obtaining supplies like masks to protect against wildfire smoke or COVID-19 may tend to agree with that action. However, if they already have enough masks at home, they may be less motivated to obtain additional masks. Conversely, people who do not have masks at home may feel motivated to obtain them. In sum, having already taken steps to protect against a health threat may moderate the relationship between priming protection views and protective behaviors.

2. Measuring outcomes

The extant literature on evaluating risk communications mostly assesses the views, intentions, and self-reported protective behaviors that result from a given communication. Rarely are tangible outcomes such as observed behavior measured, limiting the ability to assess the true effect of risk communication interventions on behavior [75–78]. In a rare example, Allaire (2106) [79] found that providing households with practical information about home retrofits and about neighbors' flood insurance behavior increased insurance uptake by 5% among 364 flood-prone households in Bangkok, Thailand. This demonstrates that effective risk communications may help improve public health and safety. Yet such interventions need to be tested in field settings.

2.1. Hypotheses

Given the balance of empirical evidence, we expect that social norms (descriptive, subjective, and injunctive), risk perceptions (personal harm and future threat), efficacy (self- and response-), and worry will be positively associated with protection views (interest in and self-reported likelihood of choosing masks and other supplies if offered) and protective behaviors (information-seeking and reported frequency of protective behaviors) regarding two critical health threats: wildfire smoke and COVID-19. Priming people to consider the reasons close social contacts are taking protective action against threats should increase social norms regarding those behaviors. We also expect that priming may directly affect protection views and the adoption of protective behaviors, potentially mediated by social norms, efficacy, risk perceptions, and worry. Finally, having already taken steps to protect against a health threat may moderate the relationship between priming and protection views. Therefore, we hypothesize (Fig. 1):

Hypothesis 1 – Stronger social norms, risk perceptions, efficacy, and worry will be associated with greater protection views and protective behaviors.

Hypothesis 2 – Priming social contact action will be associated with (a) an increase in social norms and (b) greater levels of protection views and protective behaviors than no priming or priming social contact inaction.

Hypothesis 3 – The relationship of priming with protection views and protective behaviors will be mediated by social norms, efficacy, risk perceptions, and worry.

Hypothesis 4 – The relationship of priming with protection views and protective behaviors will be moderated by having enough existing mask supplies.

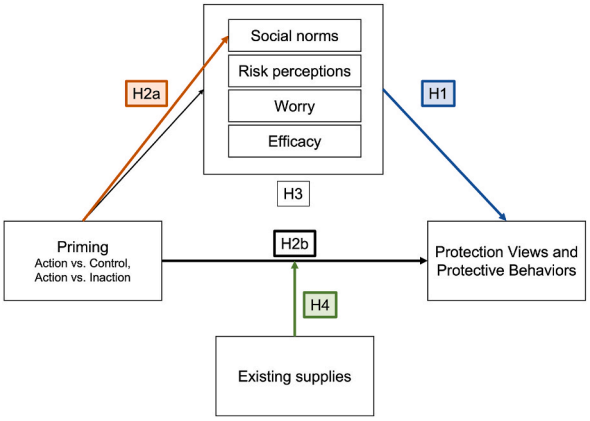

Fig. 1. Hypothesized relationships.

3. Methods

3.1. Sampling

Individuals residing in California were recruited from the NORC AmeriSpeak panel, a nationally representative panel of U.S. adults that employs area probability and address-based sampling methods. Such methods produce less biased results than convenience samples, which use snowball sampling, opt-in, or social media recruitment methods [5,6]. A total of 1,108 California panelists completed the study between December 10, 2020 and December 24, 2020; 1,068 questionnaires were completed online and 40 by phone. Participants had the option to complete the study in English ($n = 1,082$) or Spanish ($n = 26$). The median length of time to complete the survey was 19 min, and panelists were offered a cash-equivalent incentive of $3 for completing the survey.

3.2. Procedure

Fig. 2 shows the experimental procedure, which was a 2 × 3 design. First, participants' pre-treatment social norms (descriptive, subjective, and injunctive), efficacy (self- and response-), and worry regarding wildfire smoke and COVID-19 were measured. Second, participants were randomly assigned to either read a wildfire smoke or COVID-19 vignette. Third, they were then randomly assigned to one of three priming conditions: action, inaction, or control, specific to their assigned vignette. Fourth, the main outcomes of protection views (interest in and likelihood of choosing masks and other supplies if offered) and protective behaviors (information-seeking and reported frequency of protective behaviors) were measured. Fifth, participants' post-treatment social norms (descriptive, subjective, and injunctive), efficacy (self- and response-), risk perceptions (personal harm and future threat), and worry regarding wildfire smoke and COVID-19 were measured. (See SM1 for full text of vignettes and study measures.)

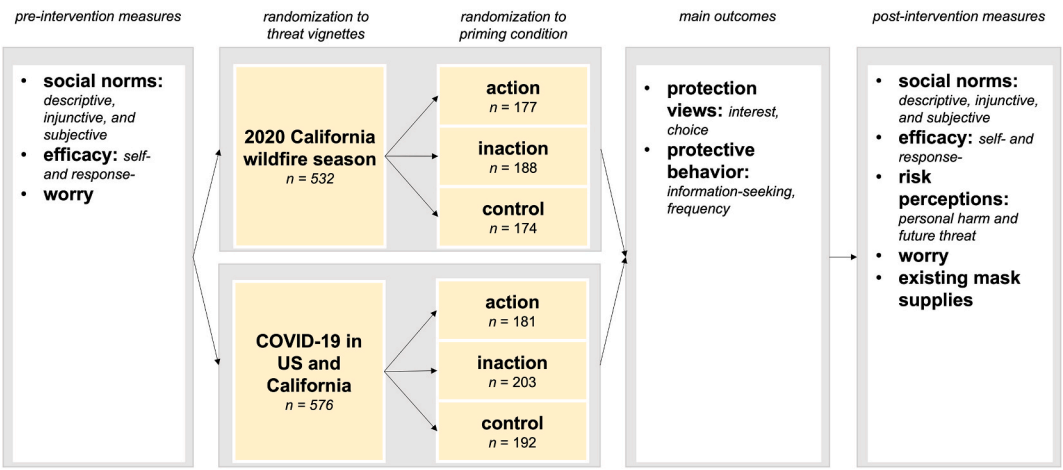

Fig. 2. Experimental procedures.

3.2.1. Pre- and post-intervention measures

- **Social norms**: All measures of social norms were assessed pre- and post-intervention. *Descriptive social norms* were assessed by asking participants to consider how many of their close social contacts would perform specific protective behaviors. *Subjective social norms* were assessed by asking participants to consider how many of their close social contacts would approve of performing specific protective behaviors. *Injunctive social norms* were assessed by asking participants to consider how many of their close social contacts would expect them to perform specific protective behaviors. All were measured on a Likert-type scale (1 = none, 5 = almost all) and assessed separately for wildfire smoke and COVID-19. Each norm was assessed as an individual item, based on previous literature [46].
- **Efficacy**: Both measures of efficacy were assessed pre- and post-intervention. *Response-efficacy* was assessed by asking participants to report their perception of how much protective behaviors reduce the harmful effects of exposure (1 = not at all, 5 = a great deal). *Self-efficacy* was assessed by asking participants how well they could perform protective behaviors to reduce the harmful effects of exposure (1 = not well at all, 5 = extremely well). Items 1 and 2 represent the conceptualization of the construct of 'adaptation appraisal' or efficacy as described by the Extended Parallel Process Model [38,80]. While these items are commonly averaged to create an index; we elected to use these items as separate predictors in our analyses to understand relationships more fully as differences between self- and response-efficacy have been observed in the literature [3,49–52]. Questions were posed separately for wildfire smoke and COVID-19.
- **Risk perceptions**: Risk perceptions were assessed post-intervention. *Personal harm* was assessed by asking participants how much they agree or disagree that it is very likely that they would be harmed from the threat if exposed (1 = strongly disagree, 5 = strongly agree). *Future threat* was assessed by asking participants how much they agree or disagree that it is very likely that the threat would affect them in the future (1 = strongly disagree, 5 = strongly agree). Items 1 and 2 represent the conceptualization of the construct of 'risk appraisal' or risk perceptions as described by the Extended Parallel Process Model [38,80]. While these items are commonly averaged to create an index; we elected to use these items as separate predictors in our analyses to understand relationships more fully as differences between personal harm and future threat have been observed in the literature [53]. Questions were posed separately for wildfire smoke and COVID-19.
- **Worry**: *Worry* was assessed pre- and post-intervention by asking participants how worried they were about harm to their health in the future from the threat (1 = not at all, 5 = extremely). The item was adapted from previous studies examining fear and worry [81,82]. Questions were posed separately for wildfire smoke and COVID-19.

3.2.2. Threat vignettes and priming conditions

- **Threat vignettes:** Participants were randomly assigned to read a vignette either about wildfire smoke or COVID-19 (see SM1).
- **Priming:** Participants were randomly assigned to one of three priming conditions: action, inaction, or control. Those in the action and inaction conditions were asked to list three reasons why their social contacts would or would not take a set of protective actions regarding their assigned threat, respectively. Those in the control condition were not prompted to list any reasons. For analyses that included all three conditions, action was coded as 1, inaction as 2, and the control as 0. For analyses that include just action and inaction, action was coded as 1 and inaction as 0.

3.2.3. Main outcomes

- **Protection views:** *Interest* was assessed by asking participants if they would be interested in having AmeriSpeak offer wildfire smoke or COVID-19 protective supplies (e.g., N95 masks and other supplies) as an option redeemable product for AmeriSpeak points (1 = not at all interested, 5 = extremely interested). *Choice* was assessed by asking participants if they would choose these protective supplies if given the opportunity (1 = not likely at all, 5 = extremely likely).
- **Protective behaviors:** *Information-seeking* behavior was assessed by asking participants to click a link if they wanted to learn more about their assigned threat (0 = no interest, 1 = interest). Assessed pre- and post-intervention, *frequency* behavior was measured by asking how often participants take actions if exposed to harm (1 = never, 5 = all the time) from their assigned threat (see SM1 for actions).

3.2.4. Context

- **Existing masks supplies**: Participants indicated whether they had enough protective masks at home for them and their family, with 0 indicating they do not have enough and 1 indicating that they do.

3.2.5. Data analytic plan

Statistical analyses were conducted using Stata (version 15.1; StataCorp). Analyses was conducted separately for those assigned to the wildfire smoke and COVID-19 threat vignettes. Descriptive statistics and correlational analyses on key variables were performed.

Hypothesis 1 was tested by conducting four ordinary least squares regression analyses with using post-intervention measured social norms (descriptive, subjective, and injunctive), efficacy (self- and response-), and risk perceptions (personal harm and future threat) predicting *protection views*: 1) interest and 2) choice and *protective behaviors*: 3) information-seeking and 4) frequency. Hypothesis 1 was also tested by separately conducting four ordinary least squares regression analyses with post-intervention measured worry

predicting *protection views*: 1) interest and 2) choice and *protective behaviors*: 3) information-seeking and 4) frequency.

Hypothesis 2(a) was tested by conducting three generalized estimating equations with priming x time predicting social norms: 1) descriptive, 2) subjective, and 3) injunctive. Additional exploratory analyses were performed by conducting two OLS regressions that examined priming as a predictor of risk perceptions: 1) personal harm and 2) future threat; and by conducting three generalized estimating equations with priming x time predicting efficacy: 1) self- and 2) response-, and 3) worry. (See SM4 for complete results.)

Hypothesis 2(b) was tested by conducting four OLS regressions with priming predicting *protection views*: 1) interest and 2) choice and *protective behaviors*: 3) information-seeking and 4) frequency.

Hypothesis 3 was tested by conducting mediation analyses using the Stata medeff package [83] with post-intervention social norms (descriptive, subjective, and injunctive), efficacy (self- and response-), risk perceptions (personal harm and future threat), and worry mediating the relationships between priming and both protection views (interest and choice) and protective behaviors (information-seeking and frequency).

Hypothesis 4 was tested by conducting OLS regressions with priming X existing mask supplies predicting *protection views*: 1) interest and 2) choice and *protective behaviors*: 3) information-seeking and 4) frequency.

The hypotheses and data analytic plan were pre-registered with the Center for Open Science's Open Science Framework prior to data analysis, see https://osf.io/v4bpg/. We have complied with all ethical regulations for work with human participants as determined by Stanford University's Institutional Review Board.

4. Results

4.1. Descriptive statistics

Prior to priming, on average, wildfire smoke participants perceived moderate descriptive ($M = 3.53$, $SD = 1.05$), subjective ($M = 3.86$, $SD = 0.99$), and injunctive norms ($M = 3.48$, $SD = 1.15$) regarding protective behaviors of their close social contacts. They expressed moderate levels of self-efficacy ($M = 3.57$, $SD = 1.03$) and response-efficacy ($M = 3.50$, $SD = 0.85$) with respect to protective wildfire smoke actions. Participants expressed moderate levels of worry about personal harm if exposed to unhealthy levels of wildfire smoke ($M = 2.42$, $SD = 1.13$). Half ($M = 50.0\%$, $SD = 50.0\%$) of participants reported having enough existing wildfire smoke mask supplies at home. Participants expressed moderate levels of interest in obtaining protective supplies against wildfire smoke ($M = 2.87$, $SD = 1.36$) and that they would choose the supplies if offered them ($M = 2.70$, $SD = 1.26$). Relatively few were interested in seeking out more information and risk reduction options regarding wildfire smoke (9.0%), however they reported that they engaged in protective behaviors a moderate amount ($M = 3.89$, $SD = 0.95$).

On average, COVID-19 participants perceived there to be relatively high levels of descriptive ($M = 4.20$, $SD = 0.93$), subjective ($M = 4.22$, $SD = 0.96$), and injunctive norms ($M = 4.17$, $SD = 1.00$) regarding the protective behaviors of their close social contacts. They expressed moderate to high levels of self-efficacy ($M = 3.99$, $SD = 0.85$) and response-efficacy ($M = 4.14$, $SD = 1.04$) with respect to protective COVID-19 actions that could be taken. Participants expressed moderate levels of worry about personal harm from COVID-19 ($M = 3.26$, $SD = 1.11$). Most participants reported having enough COVID-19 mask supplies at home ($M = 90.0\%$, $SD = 30.0\%$). Participants expressed moderate levels of interest in obtaining protective supplies against COVID-19 ($M = 2.53$, $SD = 1.41$) and that they would choose the supplies if offered them ($M = 2.56$, $SD = 1.32$). Relatively few were interested in seeking out more information about COVID-19 risk and risk reduction options (7.0%), yet reported that they engaged in protective behaviors a relatively high amount ($M = 4.55$, $SD = 0.73$). (See SM2a for full descriptive statistics results.)

Across both threats, protection views (interest and choice) were positively correlated with protective behaviors (information-seeking (wildfire: $r = 0.24$, $p < .001$; COVID-19: $r = 0.21$, $p < .001$) and frequency (wildfire: $r = 0.23$, $p < .001$; COVID-19: $r = 0.11$, $p < .01$)); however, information-seeking and frequency were not correlated. Having existing mask supplies was negatively correlated with protection views for both wildfire smoke (interest: $r = -0.12$, $p < .01$; choice: $r = -0.10$, $p < 0.05$) and COVID-19 (interest: $r = -0.25$, $p < .001$; choice: $r = -0.25$, $p < .01$). Having existing supplies was positively correlated with frequency of protective behavior in the COVID-19 condition ($r = 0.09$, $p < .05$). (See SM2b-c for correlation tables.)

4.2. Hypothesis 1 Stronger social norms, risk perceptions, efficacy, and worry are largely associated with greater protection views and frequency of reported protective behavior

4.2.1. Social norms

As shown in Table 1, for wildfire smoke, stronger injunctive norms were associated with greater interest in protective supplies, desire to choose those supplies if offered, and reported frequency of using protection when exposed to the threat. Stronger descriptive norms were also associated with greater reported frequency of engaging in protective behaviors (e.g., staying inside, wearing a face mask that filters when you go outside, sealing cracks in doors and windows) when exposed to wildfire smoke, and stronger subjective norms were associated with seeking out information about wildfire smoke. For COVID-19, stronger injunctive norms were associated with greater interested in protective supplies and reported frequency of engaging in protective behaviors (e.g., wearing face masks in public, washing hands and/or using hand sanitizer after touching surfaces outside the home) when exposed to the threat. Stronger descriptive norms were also associated with greater reported frequency of using protection. (See SM3a for full results.)

Table 1
Social norms (descriptive, subjective, and injunctive), efficacy (self- and response-), and risk perceptions (personal harm and future harm) predicting interest, choice, information-seeking, and frequency for Wildfires and COVID-19.

Variables	Wildfires				COVID-19			
	Interest n = 522	Choice n = 521	Info-seeking n = 522	Frequency n = 522	Interest n = 555	Choice n = 555	Info-seeking n = 555	Frequency n = 552
Social norms								
Descriptive	−0.07	−0.06	0.69	0.17**	-0.10	−0.14	2.18	0.10*
	(-0.26, 0.11)	(-0.23, 0.11)	(0.42, 1.12)	(0.07, 0.27)	(-0.34, 0.14)	(-0.36, 0.09)	(0.95, 4.99)	(0.004, 0.19)
Subjective	−0.09	−0.04	1.90**	0.05	−0.06	−0.003	1.08	0.01
	(-0.26, 0.08)	(-0.19, 0.12)	(1.16, 3.11)	(-0.04, 0.14)	(-0.30, 0.18)	(-0.23, 0.22)	(0.52, 2.22)	(-0.08, 0.11)
Injunctive	0.16*	0.15**	1.15	0.09*	0.24*	0.19	0.98	0.14**
	(-0.0002, 0.32)	(0.006, 0.30)	(0.73, 1.83)	(0.002, 0.17)	(0.02, 0.46)	(-0.01, 0.40)	(0.47, 2.04)	(0.06, 0.23)
Risk perceptions								
Harm	0.01	0.006	1.00	0.14**	0.25***	0.21**	1.37	0.03
	(-0.15, 0.17)	(-0.14, 0.15)	(0.64, 1.55)	(0.06, 0.23)	(0.12, 0.37)	(0.09, 0.33)	(0.93, 2.04)	(-0.02, 0.07)
Future threat	0.18**	0.12*	0.88	−0.03	0.06	0.09	0.97	−0.01
	(0.06, 0.30)	(0.004, 0.23)	(0.64, 1.23)	(-0.10, 0.03)	(-0.07, 0.19)	(-0.03, 0.22)	(0.67, 1.40)	(-0.06, 0.04)
Efficacy								
Self-	0.29***	0.26**	1.40	0.28***	−0.20*	−0.19*	0.83	0.22***
	(0.14, 0.45)	(0.11, 0.41)	(0.87, 2.26)	(0.20, 0.37)	(-0.38, -.02)	(-0.36, -0.02)	(0.47, 1.49)	(0.15, 0.29)
Response-	0.19*	0.14*	1.13	0.14**	0.18*	0.19*	0.79	0.20***
	(0.03, 0.34)	(-0.002, 0.29)	(0.72, 1.78)	(0.05, 0.22)	(0.03, 0.33)	(0.05, 0.34)	(0.51, 1.23)	(0.14, 0.26)
R2	0.14	0.12	0.06	0.46	0.08	0.08	0.05	0.48
Adjusted R2	0.13	0.11		0.46	0.07	0.07		0.47

Note. ***$p < .001$, **$p < .01$, *$p < .05$; Table shows B coefficients for interest, choice, and frequency and odds ratios for info-seeking. Values in parentheses are the 95% confidence intervals. See Supplemental Materials Table SM3a for exact p-values.

4.2.2. *Risk perceptions*

As shown in Table 1, for wildfire smoke, greater perceived future threat of wildfire smoke was associated with greater interest in and desire to choose protective wildfire smoke supplies if offered. Whereas greater perceived harm from wildfire smoke was associated with greater reported frequency of using protection when exposed to wildfire smoke. For COVID-19, greater perceived harm from COVID-19 was associated with greater interest in and desire to choose protective COVID-19 supplies if offered. Risk perceptions were not associated with threat information-seeking behavior for either wildfire smoke or COVID-19 conditions, and frequency of reported protective behavior in the COVID-19 condition. (See SM3a for full results.)

4.2.3. *Efficacy*

As shown in Table 1, for both wildfire smoke and COVID-19 conditions and across all priming conditions, stronger efficacy was associated with greater interest in protective supplies, desire to choose those supplies if offered, and reported frequency of using protection when exposed to the threat. Efficacy was not associated with information-seeking behavior about the threat for either wildfire smoke or COVID-19 conditions. (See SM3a for full results.)

4.2.4. *Worry*

As shown in Table 2, in both wildfire smoke and COVID-19 and across all priming conditions, stronger worry was associated with greater interest, choice, information-seeking, and frequency of reported behavior except for worry on information-seeking behavior in the COVID-19 condition. (See SM3b for full results.)

Table 2
Worry predicting interest, choice, information-seeking, and frequency for Wildfires and COVID-19.

Variables	Wildfires				COVID-19			
	Interest n = 529	Choice n = 527	Info-seeking n = 529	Frequency n = 527	Interest n = 575	Choice n = 574	Info-seeking n = 575	Frequency n = 570
Worry	0.60***	0.57***	1.53**	0.32***	0.44***	0.41***	1.09	0.16***
	(0.51, 0.70)	(0.48, 0.65)	(1.14, 2.04)	(0.25, 0.39)	(0.34, 0.53)	(0.31, 0.50)	(0.81, 1.46)	(0.10, 0.21)
R2	0.23	0.23	0.03	0.13	0.12	0.11	0.001	0.06
Adjusted R2	0.23	0.23		0.13	0.12	0.11		0.05

Note. ***$p < .001$, **$p < .01$, *$p < .05$; Table shows B coefficients for interest, choice, and frequency and odds ratios for info-seeking. Values in parentheses are the 95% confidence intervals. See Supplemental Materials Table SM3b for exact p-values.

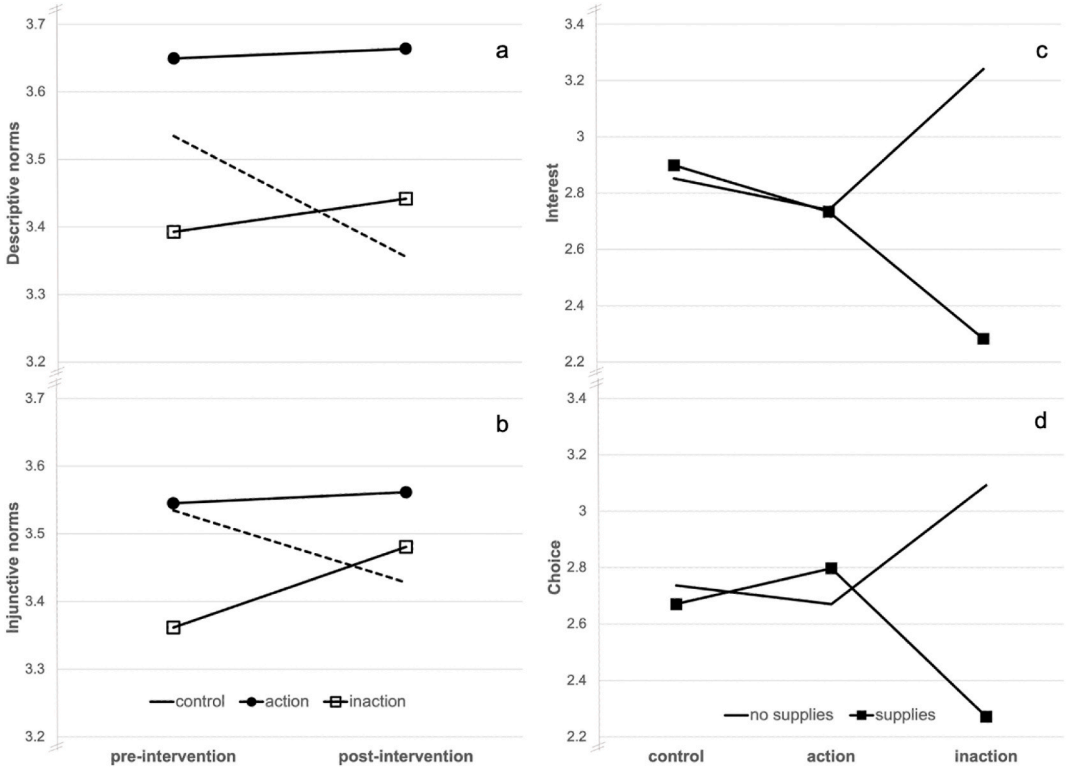

Fig. 3. Priming social contact action and inaction increased social norms compared to the control for wildfire smoke.
Note. (a) Shows predicted descriptive norms for each condition (0 = control, 1 = action, 2 = inaction) by time (pre-intervention vs. post-intervention) and (b) shows predicted injunctive norms for each condition by time. Having existing mask supplies enhanced the relationship between priming inaction and greater protection views compared to the control or priming action for wildfire smoke: (c) shows predicted interest for each condition by existing supplies (supplies vs. no supplies) and (d) shows predicted choice for each condition by existing supplies.

4.3. Hypothesis 2(a) Priming social contact action and inaction increased social norms compared to the control for wildfire smoke

In the wildfire smoke condition, priming social contact protective behavior increased perception of protective behavioral descriptive norms (i.e., what people think others are doing) compared to the control; priming action was associated with higher perception of descriptive norms compared to the control and priming inaction (see Fig. 3a). Interestingly, priming inaction also increased behavioral descriptive norms (see Fig. 3a) and injunctive norms (see Fig. 3b) compared to the control. No other significant associations were observed in the wildfire smoke or COVID-19 conditions regarding priming and other social norms. Exploratory analyses also revealed no observed significant associations in the wildfire smoke or COVID-19 conditions regarding efficacy (self- and response-), risk perceptions (personal harm and future threat), or worry. (See SM4a-b for full results.)

4.4. Hypothesis 2(b) Priming social contact action resulted in greater COVID-19 information-seeking behavior compared to the control

Priming social contact action increased information-seeking behavior in the COVID-19 condition (OR = 2.92, p = .019, 95% CI (1.19, 7.16). No other significant effects were observed for wildfire smoke or COVID-19 regarding priming with protection views or behaviors. (See SM5a-b for full results).

4.5. Hypothesis 3 Social norms indirectly mediate the relationships between priming and protection views and protective behaviors for wildfire smoke condition

Results indicated priming social contact action partially mediated protection views – both interest and choice – through descriptive and subjective norms for wildfire smoke compared to the control and through descriptive norms for priming inaction conditions (Fig. 4). We also observed that in the wildfire smoke condition, priming social contact action mediated information-seeking behavior through descriptive norms compared to priming inaction, and through subjective norms compared to the control. Response-efficacy, risk perceptions (personal harm and future threat), and worry did not mediate the relationships between priming and protection views and protective behaviors in the wildfire smoke condition. No factors – social norms, efficacy, risk perceptions, or worry – mediated the relationship of priming with protection views and behaviors in the COVID-19 condition. (See SM6a-b for additional results.)

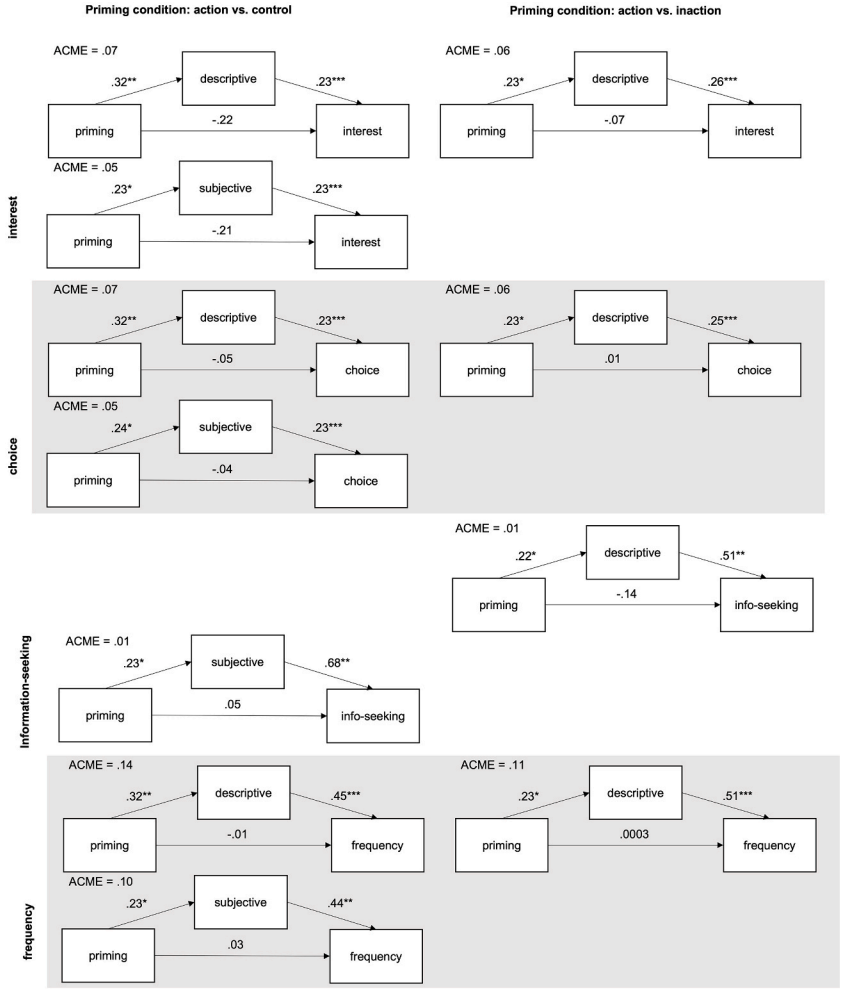

Fig. 4. Mediation and indirect effects of social norms (descriptive and subjective) and self-efficacy on the relationship between priming (left: action vs. control and right: action vs. inaction) and protection views (interest and choice) and protective behaviors (information-seeking and frequency) for wildfire smoke.
Note. For parsimony, we only show those mediations that are significant.

4.6. Hypothesis 4 Having existing mask supplies enhanced the relationship between priming inaction and greater protection views compared to the control or priming action

Having existing mask supplies was associated with stronger protection views (interest and choice) among those primed to consider social contact inaction compared to the control (Fig. 3c) and action (Fig. 3d) in the wildfire smoke condition. (See SM7a-b.) No other significant interactions were observed in either the wildfire smoke or COVID-19 conditions.

5. Discussion

In support of Hypothesis 1, and in alignment with prior research, stronger social norms (descriptive, subjective, and injunctive) [41, 45,46,56,71], efficacy (self- and response-) [48,52,57,84], risk perceptions [34, 38, 80, 85], worry [59–61,81] were largely associated with greater protection views and protective behaviors (Table 1 and SM3a-b). These findings support a number of prominent theoretical frameworks such as the Protective Motivation Theory [34], Health Belief Model [35], Theory of Planned Behavior [36], Protective Action Decision Model [37], and the Extended Parallel Process Model [38,80,85] regarding the association of our key factors and protection views and behaviors. Our findings also lend additional support for the finding in the public health and hazards literatures [59,81] that worry is positively associated with protection views and protective behaviors, at least in the context of wildfire smoke and COVID-19. Worry may be an important construct to assess in future studies that seek to understand protection views and protective behavior, and to also consider in the development of risk communications aimed at informing the public about health hazards.

In partial support of Hypothesis 2(a), we found evidence that priming was associated with an increase in social norms (descriptive, subjective, and injunctive) for wildfire smoke but not for COVID-19 (SM4a-b). As expected, we observed that priming social contact

action increased descriptive ("perception of what others are doing") and subjective ("what others approve of me doing") social norms. Unexpectedly, we also observed that priming social contact *in*action also increased subjective ("what others approve of me doing") and injunctive ("what I ought to do") social norms compared to the control. One plausible explanation for this might be a misalignment of descriptive and injunctive social norms [86,87]. Our experiment evoked *descriptive* social norms, or perceptions about why ones' close social contacts would (or would not) engage in wildfire smoke protective behaviors. However, *injunctive* social norms, or beliefs and morals about what close social contacts ought to do, regarding wildfire smoke may operate differently. Our experiment also evoked these injunctive norms: the prompt indicated that taking the suggested actions could be ways people could effectively prepare for wildfire smoke; these actions are helpful, ergo they are ones that people *should* take to protect themselves. Indeed, our findings appear to support this as we found increased descriptive norms for priming action and increased injunctive norms for priming inaction. Divergent findings in the COVID-19 condition may be because 90% of participants reported having COVID-19 masks at home, potentially creating a ceiling effect. Given that mask wearing during COVID-19 was highly politicized, it may also be that decisions regarding protective actions were less pervious to priming.

Our exploratory analyses did not yield evidence that priming increased efficacy (self- and response-) or worry or was associated with risk perceptions (personal harm and future harm) for either wildfire smoke or COVID-19. Perhaps priming close social contact protective behavior does not signal or is a weak signal of efficacy, worry, and risk perceptions. For example, priming close social contact action could signal that those actions are appropriate (response-efficacy), doable (self-efficacy), indicative of the perception that personal harm is possible (personal harm), that the threat may happen again (future threat), and that there is reason to worry. However, while these actions (or inactions) may also signal social norms, this may have little influence on ones' own perceptions and worry. This may be due to familiarity with the threats of wildfire smoke and COVID-19 and strategies for protection, with efficacy, risk perceptions, and worry strongly established. Indeed, previous studies suggest that efficacy, risk perceptions, and worry are more resistant to change given greater familiarity and experience [84,88,89,90] suggested that enhancing perceived self-efficacy may be one fruitful way to motivate people who are at the "deciding stage" (cautious, proactive, and susceptible) to take action, potentially coinciding with lower levels of threat familiarity. Future study could explore how malleable these factors are for less familiar threats, and more explicit risk communications targeting efficacy could enhance perceptions of self- and response-efficacy.

In partial support of Hypothesis 2(b), priming social contact action resulted in greater COVID-19 information-seeking behavior, but not wildfire information-seeking behavior, compared to the control condition (SM5a). COVID-19 may have felt like an immediate threat, while wildfire smoke may have been perceived as being a past or future threat. People tend to take action when threats are perceived as immediate, rather than in the past or future (e.g., preparing for the 2021 wildfire season) [37]. This may also be why we did not observe an effect of priming in the wildfire condition on smoke protective mask wearing behavior or on smoke protection views. As mentioned previously, our lack of observed movement with respect to COVID-19 protective behavior priming and mask wearing behavior or protection views may also be due to a ceiling effect. As shown in SM2, before reading the vignette people already held high levels of COVID-19 protection views and protective behaviors and most reported having enough mask supplies at home. Hence, there was no more room for a further increase in these views and behavior except for information-seeking. However, there can be additional room for learning more about COVID-19 risks and ways to protect oneself, especially during a time of increasing local cases and deaths as participants were experiencing at the time of the study. A future study could examine the effect of priming protective health behaviors before, during, and after health crises on protection views and protective behaviors to further unpack the role that immediacy of threat plays.

In partial support of Hypothesis 3, we observed that social norms (descriptive and subjective) partially mediated the relationships of priming and protection views and protective behaviors for wildfire smoke (Fig. 4, SM6a-b). This finding aligns with previous literature demonstrating the mediating role of social norms on protective behaviors [34,35]. Moreover, the evidence that priming can also *increase* social norms suggests priming may help enhance protection views and protective behaviors indirectly for less imminent threats like wildfire smoke. Further evidence found priming can also directly enhance information-seeking behavior for more immediate threats (e.g., COVID-19), although ceiling effects may have limited the effect on views and behaviors.

In partial support of Hypothesis 4, having existing mask supplies moderated the relationship between priming and protection views for the wildfire smoke condition (Fig. 3, SM7a-b). Here, not having enough mask supplies and priming inaction is associated with greater interest in obtaining protective supplies and in choosing them if offered. As discussed regarding Hypothesis 2(a), what we may be observing is a misalignment between descriptive norms (signaled by asking participants to list reasons for not taking action) and injunctive norms (protective actions described in the vignette are effective). Hence, not having supplies may put this misalignment in even more stark relief, and the inaction prime may be more effective among those who are less prepared. Future research should investigate the role that existing or expressed protective behaviors plays on the effectiveness of priming interventions specifically, and on risk communications in general. This is especially important regarding health threats with high uncertainty, such as COVID-19, which has been characterized by continual changes regarding risks and recommendations [91].

Limitations. While our study has its strengths, including its large probability-based sample and experimental design fielded in a location facing experienced and real-time threats, we also acknowledge some weaknesses. First, our vignettes stated that there are "some ways that people can reduce the harmful effects" of either wildfire smoke or COVID-19, and then listed some ways. Implicit in this framing is that these ways are effective ways to mitigate risk. Hence, signaling an injunctive norm to participants, which were aligned with descriptive norms for those primed to consider social contact action and misaligned for those primed to consider inaction. Our vignettes were framed in this way as the empirical literature suggests different social norm types all operate to influence the adoption of protective behaviors. Moreover, we also included a control group that was not designed to evoke a descriptive norm and did not see an increase relative to the priming conditions regarding social norms. Future study could more fully examine the activation of different norms by testing different types of interventions, and their respective influence on protection views and protective

behaviors.

Second, we focused on catastrophic threats that our participants had experienced (wildfire smoke) or were currently experiencing (COVID-19). Thus, participants may have already established protection views or adopted the level of protective behaviors they were willing to take. Furthermore, we observed that at the time of the study many participants already had existing mask supplies at home, especially for COVID-19. Thus, we may have observed a ceiling effect in terms of existing supplies modulating the relationships between priming and our key outcome measures. Future study could examine the effect of priming action and inaction leveraging social influences in the context of less acute threats for which people may be less prepared to see if similar patterns in findings emerge, or stronger effects from priming occur.

Third, we usedsingle-item measures of our key constructs. Literature suggests that multi-item scales are usually stronger in terms of predictive validity, as they tend to reduce ambiguity for the respondent when answering questions [92]. A future study should include multi-item scales when assessing key constructs to reduce ambiguity.

Finally, we assessed behavioral outcomes immediately after the intervention limiting insight with respect to their durability over time. These initial findings suggest that at least in the context of COVID-19, priming social norms action may promote the adoption of information seeking behavior. Hence, future study could build from these initial findings to examine how long lasting this effect is on information seeking and other behaviors over time. Designs of this nature could also carefully examine covariates such as changes in personal exposures or community-level hospitalization rates to better understand how context influences the effect of the intervention in a setting with high ecological validity.

6. Conclusions

Findings suggest priming social contact protective action or inaction activated social norms differently, with implications for the formation of protection views and the adoption of protective behaviors. While both priming conditions increased subjective norms, priming action also increased descriptive norms and priming inaction increased injunctive norms. All three norm types have previously been associated with protective attitudes and behaviors across a range of threats, from floods to air pollution [45,46]. Priming inaction appears to have highlighted a misalignment between injunctive and descriptive norms, with participants focusing on injunctive norms. For example, the vignettes described protective behaviors as effective (injunctive – "what I ought to do") yet asked participants to consider why close social contacts would not adopt them (descriptive – "what others are doing"). This advances knowledge about how priming may activate different social norms, some of which may be in conflict with one another, and that may have implications for how people perceive and respond to risks.

Results also demonstrated priming action can indirectly influence protection views and protective behaviors through social norms for less imminent but episodic threats like wildfire smoke. This finding highlights the potential for risk communications to leverage interventions evoking close social contacts to enhance social norms, which are important for the adoption of protective behaviors. We also found the context in which people make their protective health decisions matters – e.g., not having existing mask supplies – made priming inaction more salient and effective. Thus, accounting for the contexts and resources of those under threat may help improve risk communications.

For risk communications to help enhance threat understanding, recognition, and motivation to adopt protective behaviors, they must be effectively designed and deployed. Our findings highlight the importance of social influence and context for views about health protection options and protective behaviors. They suggest risk communications aimed at enhancing social norms sensitive to people's resource context may help promote adoption of protective behaviors. As severity of and susceptibility to threats such as natural disasters [19,21,31,32] and infectious disease [93] grows, designing and testing effective risk communications may help improve mitigation efforts that promote individual and community health.

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Credit author statement

Gabrielle Wong-Parodi: Conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, visualization, writing-original draft, and writing-review and editing. Dana Rose Garfin: Conceptualization, investigation, methodology, and writing-review and editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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References

[1] J.P. Carman, M.T. Zint, Defining and classifying personal and household climate change adaptation behaviors, Global Environ. Change 61 (2020), 102062, https://doi.org/10.1016/j.gloenvcha.2020.102062.
[2] Department of Homeland Security: Federal Emergency Management Agency, Preparedness in America, 2014.
[3] G. Wong-Parodi, B. Fischhoff, B. Strauss, Effect of risk and protective decision aids on flood preparation in vulnerable communities, Weather Climate Soc. 10 (3) (2018) 401–417, https://doi.org/10.1175/WCAS-D-17-0069.1.
[4] S. van der Linden, The social-psychological determinants of climate change risk perceptions: towards a comprehensive model, J. Environ. Psychol. 41 (2015) 112–124, https://doi.org/10.1016/j.jenvp.2014.11.012.
[5] V.C. Bradley, S. Kuriwaki, M. Isakov, D. Sejdinovic, X.L. Meng, S. Flaxman, Unrepresentative big surveys significantly overestimated US vaccine uptake, Nature 600 (7890) (2021) 695–700, https://doi.org/10.1038/s41586-021-04198-4, 2021.
[6] M. Pierce, S. McManus, C. Jessop, A. John, M. Hotopf, T. Ford, S. Hatch, S. Wessely, K.M. Abel, Says who? The significance of sampling in mental health surveys during COVID-19, Lancet Psychiatr. 7 (7) (2020) 567–568, https://doi.org/10.1016/S2215-0366(20)30237-6.
[7] N.A. Christakis, J.H. Fowler, Social contagion theory: examining dynamic social networks and humanbehavior, Stat. Med. 32 (4) (2013) 556–577, https://doi.org/10.1002/sim.5408.
[8] M. Galesic, W. Bruine De Bruin, M. Dumas, A. Kapteyn, J.E. Darling, E. Meijer, Asking about social circles improves election predictions, Nat. Human Behav. 2 (3) (2018) 187–193, https://doi.org/10.1038/s41562-018-0302-y.
[9] W. Bruine de Bruin, A.M. Parker, M. Galesic, R. Vardavas, Reports of social circles' and own vaccination behavior: a national longitudinal survey, Health Psychol. 38 (11) (2019) 975–983, https://doi.org/10.1037/hea0000771. Official Journal of the Division of Health Psychology, American Psychological Association.
[10] W. Bruine de Bruin, M. Galesic, A.M. Parker, R. Vardavas, The role of social circle perceptions in "false consensus" about population statistics: evidence from a national flu survey, Med. Decis. Making 40 (2) (2020) 235–241, https://doi.org/10.1177/0272989X20904960.
[11] COVID-19 United States Cases by County, Johns hopkins coronavirus resource center. https://coronavirus.jhu.edu/us-map, 2021.
[12] F. Petropoulos, S. Makridakis, Forecasting the novel coronavirus COVID-19, PLoS One 15 (3) (2020), e0231236, https://doi.org/10.1371/journal.pone.0231236.
[13] R. Chowdhury, K. Heng, M.S.R. Shawon, G. Goh, D. Okonofua, C. Ochoa-Rosales, V. Gonzalez-Jaramillo, A. Bhuiya, D. Reidpath, S. Prathapan, S. Shahzad, C. L. Althaus, N. Gonzalez-Jaramillo, O.H. Franco, Dynamic interventions to control COVID-19 pandemic: a multivariate prediction modelling study comparing 16 worldwide countries, Eur. J. Epidemiol. 35 (5) (2020) 389–399, https://doi.org/10.1007/s10654-020-00649-w.
[14] A. Irwin, What it will take to vaccinate the world against COVID-19, Nature 592 (7853) (2021) 176–178, https://doi.org/10.1038/d41586-021-00727-3.
[15] S.M. Moghadas, A. Shoukat, M.C. Fitzpatrick, C.R. Wells, P. Sah, A. Pandey, J.D. Sachs, Z. Wang, L.A. Meyers, B.H. Singer, A.P. Galvani, Projecting hospital utilization during the COVID-19 outbreaks in the United States, Proc. Natl. Acad. Sci. U.S.A. 117 (16) (2020) 9122–9126, https://doi.org/10.1073/pnas.2004064117.
[16] IPCC, Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2014.
[17] Congressional Research Service, Wildfire Statistics, 2021.
[18] Futurearth, Global Fires, 2020.
[19] C.D. McClure, D.A. Jaffe, US particulate matter air quality improves except in wildfire-prone areas, Proc. Natl. Acad. Sci. U.S.A. 115 (31) (2018) 7901–7906, https://doi.org/10.1073/pnas.1804353115.
[20] A.L. Westerling, H.G. Hidalgo, D.R. Cayan, T.W. Swetnam, Warming and earlier spring increase Western U.S. forest wildfire activity, Science 313 (5789) (2006) 940–943, https://doi.org/10.1126/science.1128834.
[21] Anthony L. Westerling, M.G. Turner, E.A.H. Smithwick, W.H. Romme, M.G. Ryan, Continued warming could transform greater Yellowstone fire regimes by mid-21st century, Proc. Natl. Acad. Sci. U.S.A. 108 (32) (2011) 13165–13170, https://doi.org/10.1073/pnas.1110199108.
[22] C. Wu, S. Venevsky, S. Sitch, L. Mercado, C. Huntingford, Modelled global wildfire patterns induced by climate change, in: Geophysical Research Abstracts, vol. 20, 2018.
[23] B. Ford, M. Val Martin, S.E. Zelasky, E.V. Fischer, S.C. Anenberg, C.L. Heald, J.R. Pierce, Future fire impacts on smoke concentrations, visibility, and health in the contiguous United States, GeoHealth 2 (8) (2018) 229–247, https://doi.org/10.1029/2018gh000144.
[24] T.B. Paveglio, C. Kooistra, T. Hall, M. Pickering, Understanding the effect of large wildfires on residents' well-being: what factors influence wildfire impact? For. Sci. 62 (1) (2016) 59–69, https://doi.org/10.5849/forsci.15-021.
[25] M. Prunicki, R. Kelsey, J. Lee, X. Zhou, E. Smith, F. Haddad, J. Wu, K. Nadeau, The impact of prescribed fire versus wildfire on the immune and cardiovascular systems of children, in: Allergy: European Journal of Allergy and Clinical Immunology, vol. 74, Blackwell Publishing Ltd, 2019, pp. 1989–1991, https://doi.org/10.1111/all.13825. Issue 10.
[26] C. Black, Y. Tesfaigzi, J.A. Bassein, L.A. Miller, Wildfire smoke exposure and human health: significant gaps in research for a growing public health issue, Environ. Toxicol. Pharmacol. 55 (2017) 186–195, https://doi.org/10.1016/j.etap.2017.08.022. Elsevier B.V.
[27] W.E. Cascio, Wildland fire smoke and human health, Sci. Total Environ. 624 (2018) 586–595, https://doi.org/10.1016/j.scitotenv.2017.12.086.
[28] J.C. Liu, L. Mickley, M.P. Sulprizio, X. Yue, F. Dominici, M. Bell, Future health effects due to wildfire smoke under climate change in the western US, ISEE Conf. Abstr. 2016 (1) (2016), https://doi.org/10.1289/isee.2016.3089.
[29] C.E. Reid, M. Brauer, F.H. Johnston, M. Jerrett, J.R. Balmes, C.T. Elliott, Critical review of health impacts of wildfire smoke exposure, in: Environmental Health Perspectives, vol. 124, Public Health Services, US Dept of Health and Human Services, 2016, pp. 1334–1343, https://doi.org/10.1289/ehp.1409277. Issue 9.
[30] J.C. Liu, L.J. Mickley, M.P. Sulprizio, F. Dominici, X. Yue, K. Ebisu, G.B. Anderson, R.F.A. Khan, M.A. Bravo, M.L. Bell, Particulate air pollution from wildfires in the Western US under climate change, Climatic Change 138 (3–4) (2016) 655–666, https://doi.org/10.1007/s10584-016-1762-6.
[31] V.C. Radeloff, D.P. Helmers, H. Anu Kramer, M.H. Mockrin, P.M. Alexandre, A. Bar-Massada, V. Butsic, T.J. Hawbaker, S. Martinuzzi, A.D. Syphard, S.I. Stewart, Rapid growth of the US wildland-urban interface raises wildfire risk, Proc. Natl. Acad. Sci. U.S.A. 115 (13) (2018) 3314–3319, https://doi.org/10.1073/pnas.1718850115.
[32] A.D. Syphard, H. Rustigian-Romsos, M. Mann, E. Conlisk, M.A. Moritz, D. Ackerly, The relative influence of climate and housing development on current and projected future fire patterns and structure loss across three California landscapes, Global Environ. Change 56 (2019) 41–55, https://doi.org/10.1016/j.gloenvcha.2019.03.007.
[33] CALFIRE, 2020 Incident Archive, 2021. https://www.fire.ca.gov/incidents/2020/.
[34] S. Prentice-Dunn, R.W. Rogers, Protection motivation theory and preventive health: beyond the health belief model, Health Educ. Res. 1 (3) (1986) 153–161, https://doi.org/10.1093/her/1.3.153.
[35] V.L. Champion, C.S. Skinner, The health belief model, in: K. Glanz, B.K. Rimer, K. Viswanath (Eds.), Health Behavior and Health Education: Theory, Research and Practice, fourth ed., Jossey-Bass, 2008, pp. 45–62.
[36] I. Ajzen, The theory of planned behavior, Organ. Behav. Hum. Decis. Process. 50 (2) (1991) 179–211, https://doi.org/10.1016/0749-5978(91)90020-T.

[37] M.K. Lindell, R.W. Perry, The protective action decision model: theoretical modifications and additional evidence, Risk Anal. 32 (4) (2012) 616–632, https://doi.org/10.1111/j.1539-6924.2011.01647.x.
[38] K. Witte, Fear as motivator, fear as inhibitor: using the extended parallel process model to explain fear appeal successes and failures, in: The Handbook of Communication and Emotion, Academic Press, 1996, pp. 423–450, https://doi.org/10.1016/B978-012057770-5/50018-7.
[39] R.B. Cialdini, M.R. Trost, Social influence: social norms, conformity and compliance, in: D.T. Gilbert, S.T. Fiske, G. Lindzey (Eds.), The Handbook of Social Psychology, McGraw-Hill, 1998, pp. 151–192. https://psycnet.apa.org/record/1998-07091-021.
[40] G. Wong-Parodi, T. Krishnamurti, J. Gluck, Y. Agarwal, Encouraging energy conservation at work: a field study testing social norm feedback and awareness of monitoring, Energy Pol. 130 (2019), https://doi.org/10.1016/j.enpol.2019.03.028.
[41] D. Abrams, M.A. Hogg, Social Identity Theory: Constructive and Critical Advances, Harvester Wheatsheaf, 1990. https://kar.kent.ac.uk/36067/.
[42] D.J. Terry, M.A. Hogg, K.M. White, Attitude–behavior relations: social identity and group membership, in: D.J. Terry, M.A. Hogg (Eds.), Applied Social Research. Attitudes, Behavior, and Social Context: the Role of Norms and Group Membership, Lawrence Erlbaum Associates Publishers, 2000, pp. 67–93. https://psycnet.apa.org/record/1999-04360-004.
[43] A. Chung, R.N. Rimal, Social norms: a review, Rev. Commun. Res. 4 (2016) 1–28, https://doi.org/10.12840/issn.2255-4165.2016.04.01.008.
[44] M.K. Lapinski, E.K. Maloney, M. Braz, H.C. Shulman, Testing the effects of social norms and behavioral privacy on hand washing: a field experiment, Hum. Commun. Res. 39 (1) (2013) 21–46, https://doi.org/10.1111/j.1468-2958.2012.01441.x.
[45] A.Y. Lo, The role of social norms in climate adaptation: mediating risk perception and flood insurance purchase, Global Environ. Change 23 (5) (2013) 1249–1257, https://doi.org/10.1016/j.gloenvcha.2013.07.019.
[46] Q. Yang, S. Wu, How social media exposure to health information influences Chinese people's health protective behavior during air pollution: a theory of planned behavior perspective, Health Commun. 36 (3) (2021) 324–333, https://doi.org/10.1080/10410236.2019.1692486.
[47] A. Bandura, Encyclopedia of Mental Health, vol. 4, Academic Press, 1994. http://www.des.emory.edu/mfp/BanEncy.html.
[48] A. Bandura, Self-Efficacy. The Exercise of Control, 1997.
[49] A. Bostrom, G. Böhm, R.E. O'Connor, Communicating risks: principles and challenges, in: Psychological Perspectives on Risk and Risk Analysis: Theory, Models, and Applications, Springer International Publishing, 2018, pp. 251–277, https://doi.org/10.1007/978-3-319-92478-6_11.
[50] R.A.C. Ruiter, L.T.E. Kessels, G.J.Y. Peters, G. Kok, Sixty years of fear appeal research: current state of the evidence, Int. J. Psychol. 49 (2) (2014) 63–70, https://doi.org/10.1002/ijop.12042.
[51] M.B. Tannenbaum, J. Hepler, R.S. Zimmerman, L. Saul, S. Jacobs, K. Wilson, D. Albarracín, Appealing to fear: a meta-analysis of fear appeal effectiveness and theories, Psychol. Bull. 141 (6) (2015) 1178–1204, https://doi.org/10.1037/a0039729.
[52] M. Kievik, J.M. Gutteling, Yes, we can: motivate Dutch citizens to engage in self-protective behavior with regard to flood risks, Nat. Hazards 59 (3) (2011) 1475–1490, https://doi.org/10.1007/S11069-011-9845-1/FIGURES/3.
[53] D.R. Garfin, B. Fischhoff, E.A. Holman, R.C. Silver, Risk perceptions and health behaviors during the emergence of COVID-19 in the United States: results from a probability-based nationally representative sample, J. Exp. Psychol. Appl. 27 (4) (2021) 584–598, https://doi.org/10.1037/xap0000374.
[54] F.H. Norris, M.J. Friedman, P.J. Watson, 60,000 Disaster victims speak: Part II. Summary and implications of the disaster mental health research, Psychiatry 65 (3) (2002) 240–260, https://doi.org/10.1521/psyc.65.3.240.20169.
[55] F.H. Norris, M.J. Friedman, P.J. Watson, C.M. Byrne, E. Diaz, K. Kaniasty, 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981-2001, Psychiatry 65 (3) (2002) 207–239. http://www.ncbi.nlm.nih.gov/pubmed/12405079.
[56] W. Bruine de Bruin, D. Bennett, Relationships between initial COVID-19 risk perceptions and protective health behaviors: a national survey, Am. J. Prev. Med. 59 (2) (2020) 157–167, https://doi.org/10.1016/j.amepre.2020.05.001.
[57] G. Wong-Parodi, B. Fischhoff, B. Strauss, Plans and prospects for coastal flooding in four communities affected by Sandy, Weather Climate Soc. 9 (2) (2017), https://doi.org/10.1175/WCAS-D-16-0042.1.
[58] G. Wong-Parodi, I. Feygina, Factors influencing (Mal)adaptive responses to natural disasters: the case of hurricane Matthew, Weather Climate Soc. 10 (4) (2018), https://doi.org/10.1175/WCAS-D-17-0138.1.
[59] R.A. Ferrer, D.B. Portnoy, W.M.P. Klein, Worry and risk perceptions as independent and interacting predictors of health protective behaviors, J. Health Commun. 18 (4) (2013) 397–409, https://doi.org/10.1080/10810730.2012.727954.
[60] K. Sweeny, M.D. Dooley, The surprising upsides of worry, Soc. Pers. Psychol. Compass 11 (4) (2017), e12311, https://doi.org/10.1111/spc3.12311.
[61] N.D. Weinstein, J.E. Lyon, A.J. Rothman, C.L. Cuite, Preoccupation and affect as predictors of protective action following natural disaster, Br. J. Health Psychol. 5 (4) (2000) 351–363, https://doi.org/10.1348/135910700168973.
[62] L. Sjoberg, Worry and risk perception, Risk Anal. 18 (1) (1998) 85–93, https://doi.org/10.1111/j.1539-6924.1998.tb00918.x.
[63] J.R. Crawford, J.D. Henry, The positive and negative affect schedule (PANAS): construct validity, measurement properties and normative data in a large non-clinical sample, Br. J. Clin. Psychol. 43 (3) (2004) 245–265, https://doi.org/10.1348/0144665031752934.
[64] K. Faasse, J. Newby, Public perceptions of COVID-19 in Australia: perceived risk, knowledge, health-protective behaviors, and vaccine intentions, Front. Psychol. 11 (2020), 551004, https://doi.org/10.3389/fpsyg.2020.551004.
[65] R.J. Dawtry, R.M. Sutton, C.G. Sibley, Why wealthier people think people are wealthier, and why it matters, Psychol. Sci. 26 (9) (2015) 1389–1400, https://doi.org/10.1177/0956797615586560.
[66] Mirta Galesic, H. Olsson, J. Rieskamp, A sampling model of social judgment, Psychol. Rev. 125 (3) (2018) 363–390, https://doi.org/10.1037/rev0000096.
[67] R.E. Nisbett, Z. Kunda, Perception of social distributions, J. Pers. Soc. Psychol. 48 (2) (1985) 297–311, https://doi.org/10.1037/0022-3514.48.2.297.
[68] T. Pachur, J. Rieskamp, R. Hertwig, The Social Circle Heuristic: Fast and Frugal Decisions Based on Small Samples, 2005.
[69] J.E. Baker, Hurricane evacuation behavior, Int. J. Mass Emergencies Disasters 9 (2) (1991) 287–310. http://www.safetylit.org/citations/index.php?fuseaction=citations.viewdetails&citationIds%5b%5d=citjournalarticle_55810_29.
[70] T.E. Drabek, Human System Responses to Disaster: An Inventory of Sociological Findings, Springer, New York, NY, 1986, p. 509, https://doi.org/10.1007/978-1-4612-4960-3.
[71] S.-K. Huang, M.K. Lindell, C.S. Prater, Who leaves and who Stays? A review and statistical meta-analysis of hurricane evacuation studies, Environ. Behav. 48 (8) (2016) 991–1029, https://doi.org/10.1177/0013916515578485.
[72] A.H. Chung, M.D. Slater, Reducing stigma and out-group distinctions through perspective-taking in narratives, J. Commun. 63 (5) (2013), https://doi.org/10.1111/jcom.12050 n/a-n/a.
[73] G.F. Kaufman, L.K. Libby, Changing beliefs and behavior through experience-taking, J. Pers. Soc. Psychol. 103 (1) (2012) 1–19, https://doi.org/10.1037/a0027525.
[74] R.S. Marvin, M.T. Greenberg, D.G. Mossler, The early development of conceptual perspective taking: distinguishing among multiple perspectives, Child Dev. 47 (2) (1976) 511, https://doi.org/10.2307/1128810.
[75] D.T. Bradley, M. McFarland, M. Clarke, The effectiveness of disaster risk communication: a systematic review of intervention studies, PLoS Curr. 6 (2014), https://doi.org/10.1371/currents.dis.349062e0db1048bb9fc3a3fa67d8a4f8.
[76] P. Bubeck, W.J.W. Botzen, J.C.J.H. Aerts, A review of risk perceptions and other factors that influence flood mitigation behavior, Risk Anal. 32 (9) (2012) 1481–1495, https://doi.org/10.1111/j.1539-6924.2011.01783.x.
[77] T. Haer, W.J.W. Botzen, J.C.J.H. Aerts, The effectiveness of flood risk communication strategies and the influence of social networks-Insights from an agent-based model, Environ. Sci. Pol. 60 (2016) 44–52, https://doi.org/10.1016/j.envsci.2016.03.006.
[78] W. Kellens, T. Terpstra, P. De Maeyer, Perception and communication of flood risks: a systematic review of empirical research, Risk Anal. 33 (1) (2013) 24–49, https://doi.org/10.1111/j.1539-6924.2012.01844.x.
[79] M.C. Allaire, Using practical and social information to influence flood adaptation behavior, Water Resour. Res. 52 (8) (2016) 6078–6093, https://doi.org/10.1002/2015WR018258.

[80] L. Popova, The extended parallel process model: illuminating the gaps in research, Health Educ. Behav. 39 (4) (2012) 455–473, https://doi.org/10.1177/1090198111418108.
[81] R.R. Thompson, D.R. Garfin, E.A. Holman, R.C. Silver, Distress, worry, and functioning following a global health crisis: a aational study of Americans' responses to Ebola, Clin. Psychol. Sci. 5 (3) (2017) 513–521, https://doi.org/10.1177/2167702617692030.
[82] D.R. Garfin, L. Djokovic, R.C. Silver, E.A. Holman, Acute stress, worry, and impairment in health care and non-health care essential workers during the COVID-19 pandemic, Psychological Trauma: Theory, Research, Practice, and Policy (2022), https://doi.org/10.1037/tra0001224.
[83] R. Hicks, D. Tingley, Causal mediation analysis, STATA J. 11 (4) (2011) 605–619, https://doi.org/10.1177/1536867x1201100407.
[84] Albert Bandura, N.E. Adams, Analysis of self-efficacy theory of behavioral changeAnalysis of self-efficacy theory of behavioral change, Cognitive Therapy and Research 1 (4) (1977) 287–310.
[85] E.K. Maloney, M.K. Lapinski, K. Witte, Fear Appeals and persuasion: a review and update of the extended parallel process model, Soc. Pers. Psychol. Compass 5 (4) (2011) 206–219, https://doi.org/10.1111/j.1751-9004.2011.00341.x.
[86] B. Borsari, K.B. Carey, Descriptive and injunctive norms in college drinking: a meta-analytic integration, J. Stud. Alcohol 64 (3) (2003) 331–341, https://doi.org/10.15288/jsa.2003.64.331.
[87] R.B. Cialdini, R.R. Reno, C.A. Kallgren, A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places, J. Pers. Soc. Psychol. 58 (6) (1990) 1015–1026, https://doi.org/10.1037/0022-3514.58.6.1015.
[88] B. Fischhoff, P. Slovic, S. Lichtenstein, S. Read, B. Combs, How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits, Policy 9 (1978).
[89] M. Siegrist, C. Keller, H.A.L. Kiers, A new look at the psychometric paradigm of perception of hazards, Risk Anal. 25 (1) (2005) 211–222, https://doi.org/10.1111/j.0272-4332.2005.00580.x.
[90] M.C. Hano, S.E. Prince, L. Wei, B.J. Hubbell, A.G. Rappold, Knowing your audience: a typology of smoke sense participants to inform wildfire smoke health risk communication, Front. Public Health 8 (2020) 143, https://doi.org/10.3389/fpubh.2020.00143.
[91] F.N. Santana, S.L. Fischer, M.O. Jaeger, G. Wong-Parodi, Responding to simultaneous crises: communications and social norms of mask behavior during wildfires and COVID-19, Environ. Res. Lett. 15 (11) (2020), 111002, https://doi.org/10.1088/1748-9326/ABBA55.
[92] A. Diamantopoulos, M. Sarstedt, C. Fuchs, P. Wilczynski, S. Kaiser, Guidelines for choosing between multi-item and single-item scales for construct measurement: a predictive validity perspective, J. Acad. Market. Sci. 40 (3) (2012) 434–449, https://doi.org/10.1007/S11747-011-0300-3/FIGURES/4.
[93] S. Gorji, A. Gorji, COVID-19 pandemic: the possible influence of the long-term ignorance about climate change, in: Environmental Science and Pollution Research, Springer Science and Business Media Deutschland GmbH, 2021, pp. 1–5, https://doi.org/10.1007/s11356-020-12167-z.