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Published online: 26 Sep 2021.

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Cognitive reasoning, risk targets and behavioral responses to COVID-19 outbreaks among Wuhan residents during lockdown

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ABSTRACT

How did residents in Wuhan, who were at the epicenter of the initial COVID-19 outbreaks in China evaluate the risk to themselves and to society at large, and take action accordingly? This study examines the need for orientation, cognitive reasoning of COVID-19 news, and perceived risk, which all contributed to protective action during the city's total lockdown. Using data collected in a mobile CATI survey during the peak of the outbreaks in February 2020, findings show that the attention to COVID-19 in digital media predicted the perception of the coronavirus pandemic as a personal risk. In addition, the need for orientation and elaboration of news about the outbreaks were positively associated with perceived risk target – personal and societal. Finally, perceived personal risk proved a stronger predictor than perceived risk to society in general for taking protective behavior.

Introduction

Over the past few decades, infectious diseases such as SARS, MERS, and COVID-19 have posed major health threats. In 2020, COVID-19 was declared a global pandemic by the World Health Organization (WHO). During such health crises understanding risk perception is vital in developing effective communication strategies and encouraging protective actions (e.g. Liu & Yang, 2020; Oh, Lee, & Han, 2020). However, risk perception is a complicated cognitive process. Two approaches have been advanced by scholars. First, the 'impersonal impact hypothesis' suggests that peoples' risk assessments will differ depending on the perceived target of risk (e.g. self, group, society); second, the 'optimistic bias' approach finds that individuals tend to believe that they are less vulnerable than others in society (Tyler & Cook, 1984; Weinstein, 1987). The 'self-other' (or self/society) distinction has been established in a variety of health contexts (e.g. Han, Zhang, Chu, & Shen, 2013; Oh, Paek, & Hove, 2015).

Mass media plays an important role in influencing risk perceptions in relation to self vs. others. Research on the abovementioned hypotheses has provided a general understanding about how different media outlets inform perceptions. But a major limitation of past research is a failure to integrate audience activity in the process of evaluating risks.

This study examines how residents of Wuhan, China evaluated risk perceptions during the initial stages of the COVID-19 outbreak. Because people rely on both traditional and digital media for information during a public health crisis, the study aimed to gauge whether people's attention to traditional media (i.e. newspapers, television) and new media (i.e. Internet, WeChat) exerted different influences on their risk perceptions. In addition, previous research shows that differences in risk perceptions could lead to different behavioral responses, ranging from inaction to self-protection and pro-community altruist actions during crises (e.g. Oh et al., 2020; Yoo, Paek, & Hove, 2020).

Research on behavioral responses in pandemics has primarily focused on health-protective practices (e.g. vaccination, hand hygiene). Few studies, however, have investigated how people protect themselves by stocking up on emergency supplies such as food and personal hygiene products. This was particularly evident in Wuhan during the COVID-19 crisis, as rigorous epidemic control measures like traffic restrictions and home-based quarantine forced people to stock up on daily necessities in advance with an attempt to ensure the basic livelihood. We examine whether the personal-level is more likely to stimulate storing behavior among Wuhan residents than the societal-level risk perception during the citywide lockdown. In considering storing behavior as a form of protection, the present study not only provides a unique insight into public responses to epidemic control policies but also expands the scope of self-protective behavior in pandemic contexts.

Drawing on the literature about impersonal influence (e.g. Coleman, 1993; Tyler & Cook, 1984), media effects (e.g. Morton & Duck, 2001; Snyder & Rouse, 1995), and cognitive reasoning (e.g. Cho et al., 2009; Namkoong, Nah, Record, & Van Stee, 2016) on personal protection during crises, we seek to investigate three major questions: (1) How did residents of Wuhan evaluate the risks to themselves and others during the initial stages of the pandemic? (2) How did cognitive motivation (i.e. need for orientation) and reasoning processes (i.e. news attention and elaboration) affect people's risk judgments at different reference levels, and especially whether variations in news attention across media channels led to differences in personal- and societal-level risk perception? And (3) did personal-level judgments of risks have a greater influence on storing behavior than that of the societal-level judgments of risks? To address these questions, a model is proposed to demonstrate how risk perception and protective actions are shaped during the outbreaks of COVID-19 in Wuhan.

Context of study

As of 28 February 2021, according to the data from the World Health Organization (WHO), 113,472,187 cases of COVID-19 had been reported globally and the virus had already killed 2,520,653 people. More worryingly, the number of confirmed cases continued to rise, signifying that the pandemic would remain a formidable challenge to global public health security.

Because of the speed and scope of its spread, COVID-19 was the most challenging public health emergency in China for over a century. Moreover, the residents of Wuhan faced the gravest threat during the early stage of the outbreak. Strict measures such as traffic control and home-based quarantine were enforced and residents had to rely solely on media to get updates on the outbreaks and to assess their risks of contracting COVID-19. A survey conducted by CVSC-SOFRES Media (CSM, a leading audience researcher in China) found that 78.7% of respondents claimed they used the social media app WeChat more frequently during the outbreak while 72.6% of respondents watched more television, especially news programs (CSM, 2020 February).

Literature review

Risk judgments at the personal and societal levels

Risk perception, a kind of 'intuitive risk judgment' according to Slovic (1987, p. 280), signifies an individual's 'attitudes, beliefs, feelings, and cognitions about risk' (Coleman, 1993, p.612). Weinstein (1987) and Tyler and Cook (1984) further distinguish variability in risk perception, noting that people tend to make a clear distinction between perceived risk to themselves relative to other targets. Personal-level risk perception has been found to have a greater impact on self-protective behavior as compared to societal-level risk perception (Sjöberg, 2010; Snyder & Rouse, 1995).

Since Furstenberg (1971) first categorized risk perception of crime victimization into personal and societal levels, scholars have expanded the self/society distinction in perceived risk to a wide variety of health contexts, including H1N1 flu (Oh et al., 2015), carcinogenic hazards (Paek, Oh, & Hove, 2016), and bovine spongiform encephalopathy (BSE) (Yoo et al., 2020). These studies suggest that people tend to make comparative risk assessments and judge their own susceptibility to risks lower than that of others.

Past research attributes the self/society gap in risk judgments to 'optimistic bias,' that is people believe they are less likely than others to experience negative events (Weinstein, 1987). Biased optimistic perception is a robust finding and has received strong support in health contexts (e.g. Cho, Lee, & Lee, 2013; Ji, Zhang, Usborne, & Guan, 2004). Meanwhile, the perceived severity of a given risk has been found to be an enhancer of the self/society perceptual gap, as the more threatening the risk, the more likely people perceive a higher risk to others than to themselves (Salmon, Park, & Wrigley, 2003).

The outbreak of COVID-19 hit the 10 million residents of Wuhan hard, fast and off guard. The booming number of confirmed cases, the unexpected city lockdown and strict close-off management of residential communities increased people's perceived severity of the risk and, in turn, made people believe other residents were more likely threatened by the coronavirus pandemic. Accordingly, this study proposes the hypothesis:

H1: People will perceive the personal risk of COVID-19 as less than the risk to others.

Cognitive reasoning and risk perception

Prior studies attribute differences in target risk assessments to media-related factors, such as media exposure (e.g. Han et al., 2013), media coverage (e.g. Stapel & Velthuijsen, 1995), and media genres (e.g. Oh et al., 2015; Paek et al., 2016). However, as we

mentioned earlier, no research has integrated audience activity into the pre-existing media effects models and examined how cognitive reasoning variables contribute to self-other differences in risk perception.

Cognitive reasoning refers to mental elaboration and collective consideration, which could take a variety of forms ranging from intrapersonal mental processes such as reflection and integration, to interpersonal communicative behaviors like discussion (Cho et al., 2009; Namkoong et al., 2016). Through reasoning, individuals attend to and process information that contain uncertainties, then arrive at judgments, estimations, and inferences of a given risk (Trumbo, 2002).

Theoretical evidence suggests that the effect of cognitive reasoning on perception should depend in fundamental ways on motivation and ability to reason (Chaiken & Trope, 1999). Motivation refers to an individual's willingness and readiness to engage in cognitive reasoning. Ability refers to an individual's physical ability to attend to and process information (Renn & Benighaus, 2013). In this study, we focused on need for orientation as a cognitive motivation, and news attention and elaboration as two reasoning cognitive mechanisms in assessing the risk caused by COVID-19.

Need for orientation and risk perception

Defined as an individual's need to familiarize himself or herself with their surroundings (Weaver, 1980), need for orientation is thought to reflect dispositional differences in cognitive motivation (Cacioppo & Petty, 1982). McCombs and Weaver (1973) emphasize relevance and uncertainty as two important factors to evaluate the degree of need for orientation. Relevance refers to the individual's interest in an issue, and uncertainty exists when people feel insecure and anxious about the situation, information and their own state of knowledge (Brashers, 2001). Generally speaking, higher relevance and uncertainty are assumed to reflect higher need for orientation (Camaj, 2014).

In a similar vein, uncertainty is an indisputable part of risk perception and higher uncertainty is assumed to reflect greater risk perception (Yang, Aloe, & Feeley, 2014). Many studies in health contexts also provide empirical evidence for a consistent association between increased uncertainty and heightened perceived risk (e.g. So, 2013; Zhao & Cai, 2009). Uncertainty is understandable in emerging health crises, especially during the initial stage of outbreaks, as scientific knowledge is often limited, official information is likely to be fluid, and rumors are disseminated widely (Gui, Kou, Pine, & Chen, 2017; Hurley, Kosenko, & Brashers, 2011). We argue that intense uncertainty inherent to a crisis situation might lead to a stronger association between need for orientation and risk perception.

Additionally, the association between personal relevance and risk perception has also been previously established in psychology and communication research (e.g. Griffin, Dunwoody, & Zabala, 1998; So, 2012). Generally, when the hazard is perceived as high in personal relevance, individuals tend to feel more threatened and highly susceptible, thus leading to greater levels of risk perception (Yang, 2015). That is, when individuals perceive the COVID-19 outbreak to be personally relevant (e.g. living in a high-risk community with many confirmed or suspected cases of COVID-19), they would likely want to monitor their surroundings and keep updated with the ongoing situation, and also perceive the severity of and vulnerability to this contagious viral disease as high.

Accordingly, a positive association between need for orientation and risk perception is tested in the next hypothesis:

H2: Need for orientation will be positively associated with risk judgments at the personal and societal levels.

News attention, elaboration and risk perception

Mass media plays a vital role in informing and shaping public perceptions especially when the risk is unprecedented and is little known (Lin, Li, & Bautista, 2016). Individuals rely on information from mass media to make risk judgments. This study identifies news attention and elaboration as two forms of cognitive reasoning as they are commonly employed to evaluate reasoning processes of media messages (e.g. Eveland, 2001; Lee, Ho, Chow, Wu, & Yang, 2013).

Attention reflects an individual's active participation with media content through focusing mental energy and cognitive effort to some specific stimulus or messages (Perse, 2001). That is to say, the impact of attention is determined by the levels of attention and content of media messages that people choose to focus on. Both traditional media and new media operate under close censorship in China, with new media to lesser degree (Tai & Sun, 2007). Thus it is not surprising that new media tend to intensify people's risk perception because they provide unfiltered information in addition to carrying messages from official mediate. In addition, comparative studies have also revealed significant differences between traditional media and new media in reporting styles, media frames, and news narratives when covering health crises (Lin & Tan, 2014; Shan et al., 2013). Meanwhile, the structural and functional differences between traditional and new media channels are also quite significant (e.g. Eveland & Dunwoody, 2001). It is thus very worthwhile to separately investigate whether coronavirus related news attention on traditional media and new media would exert distinct impacts on one's risk perception.

With regard to traditional media we focused on television and newspapers as they enjoy higher penetration rate in China than other traditional media channels (Zhou & Lu, 2017). For new media, we investigated the Internet as a source of information, and specifically the social media app WeChat, due to the fact that digital information services were the most popular means of accessing coronavirus news during the outbreak of COVID-19 (CSM, 2020 February).

Internet-based media and social media are generally assumed to play a large role in enhancing the degree of perceived personal risk as customized Internet services tend to provide people with news that is more personally relevant, which very easily triggers their personal concerns (e.g. Han et al., 2013). And informed by the impersonal impact hypothesis, WeChat, characterized as the most influential interpersonal communication channel in China, is also very likely to intensify people's personal-level risk perception (e.g. Morton & Duck, 2001; Snyder & Rouse, 1995).

Thus, we would argue that newspapers and television tend to exert influence on individual's risk perception mostly at societal-level. Our argument is grounded in the observation that coverage of epidemics tends in press and on TV to describe risks as a threat to generalized others, something audiences can interpret as 'distant to me' but might

'happen to others' (Cho et al., 2013; Snyder & Rouse, 1995). Accordingly, we assume that the greater attention paid to news on the Internet and WeChat is more likely to intensify personal-level risk perception, while increased attention paid to newspaper and television news might lead to higher risk perception at societal-level.

H3a: Attention to news about COVID-19 on new media (Internet and WeChat) will be positively associated with personal-level risk perception.

H3b: Attention to news about COVID-19 on traditional media (newspaper and television) will be positively associated with societal-level risk perception.

Elaboration has been recognized as another central reasoning process that represents a higher level of involvement when processing media messages (Eveland, 2002). It refers to the process of retrieving new information from the media and assimilating the information with existing knowledge and prior experience stored in memory; through it, new information that is integrated into the existing cognitive structure would be easily accessible for individuals to formulate judgments about the risk (Eveland, 2001; Ho, Peh, & Soh, 2013).

Elaborative processing of COVID-19 news might prompt people to relate the present situation with past experiences such as SARS and think deeply about consequences of the threat. Such a reasoning process would make people feel that COVID-19 is highly relevant to them, feel more vulnerable, and thus increase levels of risk perception. In light of these considerations, we hypothesize the following:

H4: Elaboration of news about COVID-19 will be positively associated with risk judgments at the personal and societal levels.

Protective behavior during the lockdown

Some health-related theories and models, such as the Health Belief Model (HBM, Janz & Becker, 1984), the Extended Parallel Processing Model (EPPM, Witte, 1994), and the Protection Motivation Theory (PMT, Rogers, 1975), emphasize the central role of risk perception in influencing individual's behavioral responses. For instance, the HBM demonstrates that the stronger people's perceived threat of a given risk, the more they will be motivated to cope with the threat by engaging in health-protective actions (Janz & Becker, 1984). In particular, according to the EPPM, if a threat is perceived as personally relevant, people are more likely motivated to perform protection behavior (Witte, 1994; Witte & Morrison, 2000). That is, increased perceived relevance, whether physical proximity or psychological closeness, would strengthen the persuasive effects of risk perception on coping behavior (Huang & Yang, 2017; Johnson, 2018). Accordingly, this study assumes that perceived risk to self will be a stronger driver of protective actions than perceived risk to society.

Empirical studies in pandemic contexts suggest that individuals with greater perceived risk tend to increase immunization practices (Liu & Yang, 2020), hand hygiene practices (Ho et al., 2013), and social distancing practices (Oh et al., 2020) in order to reduce the threat of infectious disease on their health. In addition to posing a direct threat on public health, pandemics in fact also bring inconvenience to people's daily life as product shortages occur during pandemics (e.g. Quinn, 2020, May 6). As such, stocking up on

daily necessities (i.e. food, water), household products (i.e. toilet paper, hand sanitizer), and medical supplies (i.e. antipyretics, medicinal alcohol) in response to potential short supplies fall into the category of protection.

In particular, the strict lockdown management of residential communities in Wuhan significantly increased the difficulty of normal purchasing. In such circumstances storing behavior is likely to be adopted as a coping strategy to reduce perceived risk (King & Devasagayam, 2017; Sternquist, 2007). Accordingly, this study assumes that a higher perceived risk to oneself will more strongly motivate people to stock up on emergency supplies for protection than a higher perceived risk to society.

> **H5:** Personal-level risk judgments will be a stronger predictor of protective behavior than will societal-level risk judgments.

Past research has identified the effects of cognitive reasoning on promoting protective behavior. For instance, Ho et al. (2013) found that increased news attention and elaboration would lead to more precautionary behavior in the context of H1N1 pandemic. Accordingly, we assume that news attention and elaboration will also function as positive predictors of storing behavior during the outbreak of COVID-19.

> **H6:** Cognitive reasoning processes (news attention and elaboration) will be positively associated with protective behavior.

As the existing research reveals that cognitive reasoning is predictive of risk perception, and risk perception plays certain roles in promoting self-protection. This study, therefore, assumes that cognitive reasoning might stimulate protective behavior indirectly through influencing one's risk assessments. Given the lack of empirical evidence, this study thus raises a research question:

> **RQ1:** Will personal-level risk judgments mediate the association between cognitive reasoning (news attention and elaboration) and protective behavior?

The theoretical model

By adapting and synthesizing aspects of social psychology theories, recent work has developed different models to articulate the associations between risk-related cognition, attitudes, and behavior. Lin et al. (2016) proposed a model to examine how news attention, interpersonal discussion, and knowledge affect Singaporeans' perceived risk towards haze and their intention to undertake self-protective behavior. A study by Liu and Yang (2020) explored how media attention, online discussion, and social trust influence Chinese parents' risk perception and vaccination intention. As these empirical studies yielded inconsistent patterns of relationships among cognitions, attitudes, and behaviors across contexts, it is thus necessary to reexamine the associations in the context of the COVID-19 crisis.

This study proposes a model that articulates the theoretical linkages among need for orientation, news attention, elaboration, risk perception, and protective behavior during the outbreak of COVID-19. As shown in Figure 1, the model starts with need for orientation, which leads to news attention, which leads to news elaboration, which in turn predicts perceived risk to the self. Risk perception then predicts protective behavior. Particularly, cognitive-reasoning variables may ultimately influence protective behavior,
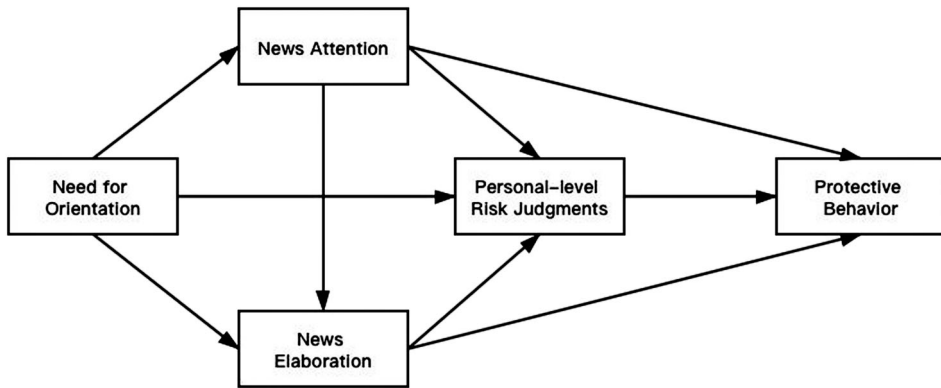
Figure 1. The proposed theoretical model.

possibly mediated through self-relevant risk perception. The theoretical model is based on the literature review from which we developed our hypotheses and research question.

Method

Sampling

The penetration rate of mobile phones in China is much higher (113.9%, till 2020) than land-lines. A mobile Computer-Assisted Telephone Interviewing (CATI) survey was therefore conducted in Wuhan from 15 February to 10 March 2020 to collect data via a leading market research company. In China, there are no mobile phone directories that can be used as sampling frame, but each city has its own number blocks that can be used as prefixes to generate random mobile numbers. That is, mobile phones in China have eleven-digit numbers, the first three digits identify the operator, the 4th to 8th digits identify the city, and the last three digits are random numbers. This study's sample was therefore comprised of RDD numbers being generated from the operator prefixes, the city (Wuhan) prefixes, and the random numbers for suffixes. Before formally launching the investigation, interviewers asked whether the respondent was now living in Wuhan and under home isolation, if not, they thanked the respondent and finished the interview. A total of 70,164 phone calls were made, and 1071 interviews were completed, yielding a response rate of 4.67%.

Of the sample, gender was evenly distributed. A total of 552 (51.5%) respondents were male and 519 (48.5%) were female. The age distribution of respondents ranged from 18 to 82 ($M = 41.69$). Among the respondents, about 8.2% (88) between 18 and 24 years, 28.0% (300) between 25 and 34 years, 21.48% (230) between 35 and 44 years, 19.2% (206) between 45 and 54 years, and 23.1% (247) aged 55 and older. All of the 13 districts in Wuhan were covered with an average of 82 respondents per district.

Measurement of key variables

Attention to news about COVID-19 outbreaks in traditional media. Respondents were asked to indicate how much attention they paid to news about COVID-19 outbreak in newspapers and on television. The 5-point response categories ranged from '1' ('no attention at all') to '5' ('a great deal of attention'). A composite measure of 'attention to news

about COVID-19 outbreaks in traditional media' was constructed by averaging the two items ($M = 2.24$, $SD = .93$; $r = .09$, $p < .01$).

Attention to news about COVID-19 outbreaks in new media. Respondents were asked to indicate how much attention they paid to news about COVID-19 outbreaks on Internet and WeChat respectively. The 5-point response categories ranged from '1' ('no attention at all') to '5' ('a great deal of attention'). A composite measure of 'attention to news about COVID-19 outbreaks in new media' was constructed by averaging the two items ($M = 2.76$, $SD = .93$; $r = .35$, $p < .001$).

Need for orientation. Respondents were asked to what extent they agreed with the following statements on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree): (1) It is important for me to stay informed about the COVID-19 issue; (2) I want to know about all aspects of the COVID-19 issue; (3) I want to have in-depth understanding of the COVID-19 issue; and (4) I need to instantly learn about the COVID-19 issue. Principal components analysis showed that the four items were grouped in a single factor, thus indicating that they measured the same underlying concept. The single-factor solution explained 68.00% of the total variance (Eigenvalue = 2.72). The average of the four items was used to create a composite index of 'need for orientation' ($M = 4.29$, $SD = .54$, $\alpha = .84$).

Elaboration of news about COVID-19 outbreaks. Using a 5-point Likert scale, where 1 meant 'strongly disagree' and 5 meant 'strongly agree,' respondents were asked to indicate their agreement with four statements: After reading/viewing news reports about COVID-19 outbreaks, (1) I have thought about the consequences of the coronavirus pandemic on my life and work; (2) I have considered the information comprehensively and have drawn my own conclusions; (3) I have compared and evaluated the information and found some were credible while some were not; (4) I have assessed my own and families' likelihood of being infected. The four items measured a single underlying construct in an exploratory factor analysis (eigenvalue = 2.04, variance accounted for was 50.91%). They were averaged to generate a composite measure of 'news elaboration' ($M = 4.01$, $SD = .57$, $\alpha = .68$).

Perceptions of risk. Informed by Tyler and Cook (1984) and Sjöberg (2012), this study measured respondent's risk judgments for two targets: self and society. Perceived risk to self refers to the individual's estimate of his/her own risk of being victimized. Perceived risk to society refers to the individual's estimation of the generalized level of risk to the larger community. Specific measurements were as follows:

Risk judgments at personal level. We assessed the risk target by focusing on self-relevant risk perception using four items adapted from previous research (Krieger & Sarge, 2013; Nan & Kim, 2013). On a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree): (1) I am at risk for getting infected with COVID-19; (2) It is likely that I will contract the coronavirus; (3) I believe that COVID-19 is extremely harmful to my health; (4) I believe that COVID-19 is a serious threat to my life. Results of an exploratory factor analysis showed a single-factor solution, suggesting these four items measured the same concept (Eigenvalue = 2.47, explaining 61.68% of the variance). A composite scale was created by averaging them ($M = 3.48$, $SD = .82$, $\alpha = .79$).

Risk judgments at societal level. Respondents were asked to indicate to what extent they agreed with the following statements on a 5-point scale ranging from 1 (strongly

disagree) to 5 (strongly agree): (1) Other Wuhan residents are at risk of getting infected with COVID-19; (2) It is likely that other Wuhan residents will contract the coronavirus; (3) I believe that COVID-19 is extremely harmful to other Wuhan residents' health; (4) I believe that COVID-19 is a serious threat to other Wuhan residents' life. These items were subjected to a principal component factor analysis, in which a single-factor solution emerged (eigenvalue = 2.94, accounted for a total of 73.52% of the variance). A composite measure was created by averaging the four items (M = 3.95, SD = .76, α = .88).

Protective behavior. On a 5-point scale ranging from 1 (never) to 5 (always), respondents were asked to report on how often they had stocked up on the following products during the outbreaks: (1) food; (2) masks; (3) sanitary products such as alcohol, hand sanitizer, and disinfectant liquid; and (4) potential drugs for curing or preventing the coronavirus. The four items were loaded in a single factor in an exploratory factor analysis. The one factor solution accounted for 56.15% of the variance (eigenvalue = 2.25). The average of the items was used to form a composite measure of protective behavior (M = 2.99, SD = .97, α = .73).

Control variables. Key demographics were included as control variables. Respondents were asked to provide their gender, age, education, and income. These variables were used as controls in the subsequent regression analyses because previous studies indicated that they were related to need for orientation, cognitive reasoning, and risk perception (e.g. Choi, Yoo, Noh, & Park, 2017; Ho et al., 2013; Slater & Rasinski, 2005).

Results

H1 predicted that people would perceive the personal risk of contracting COVID-19 as less than the risk to others. Table 1 presents the results of the paired *t-tests*, which provided support for this hypothesis for both individual measures and the combined effects index [t (1071) = −20.98 at the p < .001]. H1 was thus supported.

Two parallel hierarchical regression analyses were performed to test the effects of cognitive reasoning variables on risk perception at two levels while controlling for demographics (See Table 2). H2 predicted that need for orientation would be positively associated with both personal-level risk perception (β = .16, p < .001) and societal-level risk perception (β = .24, p < .001) was supported. H3a predicted that attention paid to COVID-19 news on new media would be positively associated with personal-level risk perception was also supported (β = .08, p < .05). H3b, which assumed a positive association between traditional media attention and societal-level risk perception (β = −.03,

Table 1. Mean estimates of risk judgments at personal and societal levels.

Risk targets	Items	N	M	SD	t-value
Self	I am at risk for getting COVID-19	1071	3.29	1.08	−19.21***
Society	Other Wuhan residents are at risk for getting COVID-19	1071	3.98	.86	
Self	It is likely that I will contract COVID-19	1071	3.07	1.09	−25.06***
Society	It is likely that other Wuhan residents will contract COVID-19	1071	3.93	.86	
Self	COVID-19 will damage my health	1071	3.80	1.00	−6.51***
Society	COVID-19 will damage other Wuhan residents' health	1071	3.99	.89	
Self	COVID-19 will pose a big threat to my life	1071	3.75	1.03	−5.36***
Society	COVID-19 will pose a big threat to other Wuhan residents' lives	1071	3.91	.93	
Combined index of risk perception at personal level		1071	3.48	.82	−20.98***
Combined index of risk perception at societal level		1071	3.95	.76	

Table 2. Hierarchical regression predicting risk perception.

	Model 1: Risk perception at personal level	Model 2: Risk perception at societal level
Block 1: Control variables		
Gender	.02	.01
Age	.15***	−.00
Education	.07*	.11**
Income	−.03	−.00
Adjusted R^2	1.9%	1.7%
Block 2: Cognitive motivation		
Need for orientation	.16***	.24***
Adjusted R^2	8.2%	13.6%
Block 3: Reasoning processes		
Traditional media attention	−.05	−.03
New media attention	.08*	.05
Elaboration	.16***	.20***
Adjusted R^2	10.5%	16.5%

Note: Figures in the table are $N = 1071$. Cell entries are standardized regression coefficients. Gender (1 = male, 0 = female). ***$p < .001$; **$p < .01$; *$p < .05$.

$p > .05$), was rejected. Elaboration was found a significant positive predictor of risk perception at both personal-level ($\beta = .16$, $p < .001$) and societal-level ($\beta = .20$, $p < .001$). H4 was thus supported.

Another regression analysis was conducted to examine the effects of cognitive reasoning variables and risk perception on protective behaviors while controlling for demographics (See Table 3). The results suggested that risk perceptions at personal level ($\beta = .12$, $p < .01$) would be more strongly and positively associated with protective behavior than risk perceptions at societal level ($\beta = .05$, $p > .05$). Thus, H5 was supported. H6 was also supported as people who paid more attention to COVID-19 news in traditional media ($\beta = .11$, $p < .001$) and in new media ($\beta = .10$, $p < .01$) were more likely to stock up on goods for protection during the lockdown. The association between elaboration and protective behavior was significant before risk perception variables entered into the model ($\beta = .07$, $p < .05$), however, the association became non-significant after two

Table 3. Hierarchical regression predicting protective behavior.

	Model 1	Model 2	Model 3	Model 4
Block 1: Control variables				
Gender	−.03	−.03	−.03	−.03
Age	−.04	−.05	−.08*	−.10**
Education	.13***	.12***	.11**	.09*
Income	−.03	−.02	−.02	−.02
Adjusted R^2	1.9%	1.9%	1.9%	1.9%
Block 2: Cognitive motivation				
Need for orientation		.09**	−.01	−.04
Adjusted R^2		2.5%	2.5%	2.5%
Block 3: Reasoning processes				
Traditional media attention			.11**	.11***
New media attention			.11**	.10**
Elaboration			.07*	.05
Adjusted R^2			4.9%	4.9%
Block 4: Risk perception				
Risk perception at personal level				.12**
Risk perception at societal level				.05
Adjusted R^2				6.6%

Note: Figures in the table are $N = 1071$. Cell entries are standardized regression coefficients. Gender (1 = male, 0 = female). ***$p < .001$; **$p < .01$; *$p < .05$.

levels of risk perception were introduced into the model ($\beta = .05$, $p > .05$). Such a result suggested the possibility of a mediation effect which would be further analyzed through bootstrapping procedure and Sobel test.

A series of mediation analysis was conducted through the PROCESS macro version 2.16 developed by Hayes (2013) to provide an answer for RQ1. The demographic variables of gender, age, education, and income were controlled in mediation analyses and accounted for in all analyses. The data were bootstrapped to 5000 resamples drawn from our sample of 1071, and 95% bootstrap confidence intervals (CIs) were generated for inference tests. Meanwhile, results of Sobel tests were also presented with an attempt to provide further confirmation for these mediating effects. Results were summarized in Table 4.

Results of bootstrapping and Sobel test indicated that risk perception at personal level significantly mediated the influence of attention to COVID-19 news via new media (effect = .021, 95% CIs [.010, .036], $z = 3.50$, $p < .001$) and elaboration (effect = .060, 95% CIs [.035, .094], $z = 4.00$, $p < .001$) on protective behavior. That is, risk judgments at personal level were a significant mediator in the relationship between cognitive-reasoning variables (new media attention and elaboration) and protective behavior.

To test the proposed model, we implemented structural equation modeling using Mplus 7.4 and results were shown in Figure 2. Results of the analyses indicated that although the chi-square for the model was significant, $\chi^2 = 178.527$, $df = 68$, $p < .001$; (χ^2/df ratio = 2.63), the comparative fit index (CFI = .974), the Tucker–Lewis index (TLI = .966), the root mean square error of approximation (RMSEA = .039), and the Standardized Root Mean Square Residual (SRMR = .030) indicated that the model fit was acceptable. The model explained 27.6% of the variance in news attention, 39.8% in news elaboration, 12.9% in risk perception at personal level, and 6.0% in protective behavior.

Discussion

This study explored three research questions: (1) How did residents of Wuhan evaluate the risks to themselves and others during the initial stages of the pandemic? (2) How did cognitive reasoning variables affect people's risk judgments at different reference levels? And (3) how did risk perception affect storing behavior directly and indirectly through cognitive reasoning?

Regarding the first research question, we found that people separated their personal and societal level judgments about COVID-19 risks, and consistent with optimistic

Table 4. Indirect effects of reasoning processes on protective behavior through risk perception at personal level.

	Effect size	SE	95% Bootstrap CI	
			Lower limit	Upper limit
New media attention	.021	.006	.010	.036
Elaboration	.060	.015	.035	.094

Note: Estimates were calculated using the PROCESS macro developed by Hayes (2013). CI = confidence interval. Cis are based on the bootstrapping of 5000 sample. $N = 1071$.
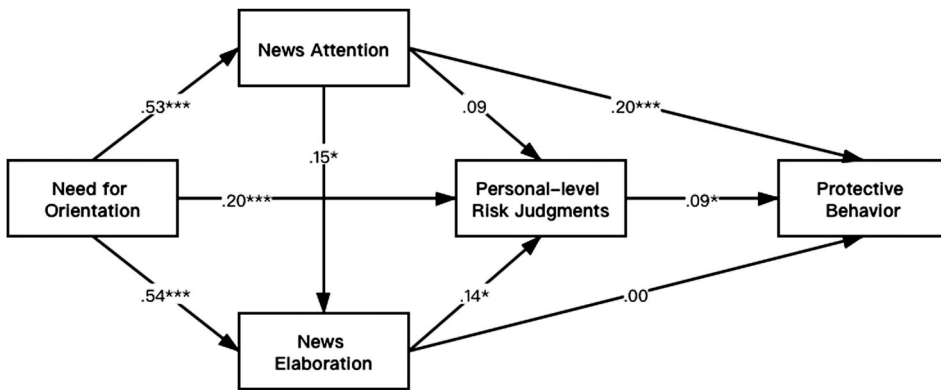
Chi−square=178.527; *df*=68; *p*<.001; Chi−square/*df* ratio=2.63; CFI=.974; TLI= .966; RMSEA=.039;SRMR=.030

Figure 2. The structural equation model.

bias, people believed they were less susceptible to the threat of COVID-19 than were other Wuhan residents. We expanded past findings of self/society perceptual gap in risk perception from common health problems (i.e. cancer, smoking, drug use) to a public health emergency and suggested that such biased optimistic perception might be a more general effect in health contexts. To expand on the target risk judgment studies, it is necessary to separate risk perception into more diverse levels of references, from personal level to group level to societal level and even to global level, and cover a wider range of hazards and risks.

With regard to the second research question, we found that need for orientation turned out to be the strongest predictor of both personal-level and societal-level risk perceptions. Considering the high level of uncertainty characterized the COVID-19 crisis, especially in the early stage, due to a lack of scientific knowledge about the disease such as symptoms, transmission, and virulence, one possible explanation might be uncertainty caused by the outbreaks amidst proliferation of rumors and false information (infodemics) leads to heightened need for orientation. That is, higher uncertainty inherent to the COVID-19 crisis would lead to a stronger need for orientation, and also higher levels of risk perception.

Contradictory to our expectations, attention to COVID-19 news on newspapers and television failed to predict societal-level risk perception. This may be because media frames play a critical role in shaping the public's perception of the pandemic, and the frames used in Chinese news reports of COVID-19, especially in print media and television, tended to construct a positive picture of the Chinese government and the whole society, placed more emphasis on the government's efforts and achievements in controlling the outbreaks, conveyed an optimistic future for the general public (Liu, 2020; Shen, 2020). Given such a context, people who paid more attention to COVID-19 news in newspapers and television would probably not perceive greater risks at societal-level.

On the other hand, this study confirmed greater attention paid to new media led to higher risk perception at the personal level. As Internet services with personalized information tends to provide people with news that is more personally relevant, and news on WeChat usually comes from close friends, families, and acquaintances, this greater sense

of trust and familiarity more easily intensified people's risk perception at the personal-level (Han et al., 2013).

Recognized as another key cognitive reasoning process, elaboration was found in this study as a significant predictor of risk perception at both levels. As elaboration is a higher depth of reasoning process through which new information would be associated with prior experience, the outbreak of COVID-19 was very likely to remind respondents of the alarming memories of SARS. As thus, through elaborative processing, respondents having experienced SARS tended to feel more threatened by the risk of infection in the event of COVID-19 outbreak for both themselves and other residents.

The last research question, and the most important one, aimed to address the association between risk perception and self-protection. Given that strict access control was enforced in all residential communities, nearly 10 million people were under home isolation in Wuhan. Stocking up on daily necessities emerged as a prominent self-protection behavior during the outbreak of COVID-19. As expected, our findings show that personal-level risk perception served as a stronger predictor of the storing behavior than societal-level risk perception. This result suggested that stocking up on emergency supplies is more likely adopted as a coping strategy to reduce personal anxieties rather than social anxieties (Snyder & Rouse, 1995; Sternquist, 2007). To mitigate social-level risk perception, people might tend to perform specific pro-social behavior which would benefit the whole society such as providing informational, emotional and financial support for people in need (e.g. Yang, 2015). Future studies need to expand the scope of behavioral responses on a case by case basis. Such expansion would deepen our understanding of people's coping strategies during crises and help develop effective risk communication tactics.

To better articulate the impact of risk-related cognitions and attitudes on protective behavior, this study proposed a theoretical model – which we called the Cognitive-Risk Perception-Behavior Model (C-RP-B – postulating that risk perception would mediate the association between cognitive reasoning and protective behavior). By attending to news about COVID-19 and elaborative processing, people may perceive the risk of products shortages during the city lockdown, which may consequently increase their likelihood of stocking up on emergency supplies. The traditional cognition-attitude-behavior model mainly emphasized the mediating role of objective knowledge or emotional responses (e.g. Ho et al., 2013; Shim & You, 2015); the C-RP-B model suggested risk perception to be an important mediator of human responses in risky situations. As risk assessments are generally made in the face of any threat, recognizing the role of risk perception on stimulating behavioral responses, especially on encouraging protective actions, is thus crucial and should be given greater prominence in risk analysis and health communication studies.

Several limitations of this study are acknowledged. As the data were collected with a cross-sectional survey, causality could not be established. Although the research model was grounded in theories, there is a possibility of reverse casual relationships. To justify causal claims, experimental designs and longitudinal studies are suggested in future studies. Another limitation is that the measure of protective actions is limited to storing up goods, while other important protective behaviors like social distancing and personal hygiene practice were not measured. Also, in this study, we focused on how cognitive mechanisms (e.g. attention and elaboration to COVID-19 news in news

media) affect risk perception. Other relevant variables such as information control during the outbreaks affect the perceptions were not included due to limit of questions set by telephone survey. Future research should expand the variables to seek a fuller explanation of risk perceptions during a pandemic crisis.

The last limitation lies in the generalizability of the findings. As this study was conducted in a locked-down Chinese city during the peak of the COVID-19 outbreak, it is unclear to what extent these findings could be generalized to other regions and other stages of the pandemic. As the COVID-19 epidemic is still going in almost all countries and the virus very likely will be with us for a long time, it is necessary to replicate the model in diverse contexts for possible consistent patterns, and further increase the overall generalizability of the theoretical model.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

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