



Human and Ecological Risk Assessment: An International Journal

ISSN: (Print) (Online) Journal homepage: <https://www.tandfonline.com/loi/bher20>

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Branden B. Johnson & Marcus Mayorga

To cite this article: Branden B. Johnson & Marcus Mayorga (2021): Americans' early behavioral responses to COVID-19, Human and Ecological Risk Assessment: An International Journal, DOI: [10.1080/10807039.2021.1884842](https://doi.org/10.1080/10807039.2021.1884842)

To link to this article: <https://doi.org/10.1080/10807039.2021.1884842>



Published online: 27 Feb 2021.



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Branden B. Johnson and Marcus Mayorga

Decision Research, Eugene, OR, USA

ABSTRACT

Understanding human responses to pandemics can improve public health. A survey of US residents ($n=2004$) February 28, 2020, very early in the coronavirus pandemic, tested predictors of five “protective” actions: washing hands, wearing masks, avoiding travel, avoiding large public gatherings, and avoiding Asians (given COVID-19's first appearance in China). We added to the Protective Action Decision Model—positing threat, protective action, and stakeholder perceptions as immediate predictors of intentions—objective and subjective coronavirus knowledge as predictors of these perceptions, and psychological distance to predict threat perceptions. We presumed objective and subjective knowledge were affected by following US and China news about COVID-19. Structural equation modeling indicated adequate fit for this parsimonious model; variance explained in behavioral intentions ranged from .12 (handwashing) to .33 (Asians). Behavioral intentions rose with higher threat, action, and stakeholder (trust) perceptions, psychological distance reduced threat perceptions, objective knowledge reduced threat and action perceptions but increased trust, and subjective knowledge did the opposite. Coronavirus-news following increased both objective and subjective knowledge, but subjective knowledge exhibited stronger associations and US news dominated China news. Moderate model fit and variance explained might reflect model parsimony and/or data collection when US cases were in the low double digits.

ARTICLE HISTORY

Received 6 November 2020

Revised manuscript

Accepted 30 January 2021

KEYWORDS

Coronavirus; COVID-19;
protective behavior

Introduction

The sudden observation in Wuhan, China in December 2019 of humans infected with a new coronavirus (officially SARS-CoV-2 virus) provides yet another example of scientists and policymakers being surprised as a virus observed in animal and/or bird populations, or transmitted by mosquitoes, became virulent in humans (e.g., two coronaviruses: SARS 2002–2003, MERS 2012; recent major outbreaks of Ebola virus, 2014–2016, and Zika virus, 2015–2017). The virus' multiple impacts on the human body—primarily pulmonary (lung), but with cardiac and other effects—were designated as the disease COVID-19. Spreading in exponential fashion throughout the world, as of late January 2021 the U.S. had officially recorded nearly 26 million cases (about a quarter of the world's total) and nearly 432,000 deaths, according to U.S. Centers for Disease Control and Prevention (CDC) records. Understanding how people react to such novel and rapidly expanding hazards under uncertainty is necessary to learn how

to avoid either undue apathy or undue panic in behavioral responses. Here we use a cross-sectional survey of Americans in late February—launched on the very day that the first non-travel-related case of COVID-19 was announced in the U.S., with 43 total national cases officially noted by the CDC as of March 2 (and 17 cases according to Johns Hopkins University records)—to test a model of public protective behavioral actions and intentions early in the U.S. pandemic. We find that the model works for multiple COVID-19 protective behavior intentions, if with variations in the strength of links between specific variables.

Background

As our data collection occurred February 28, 2020, it is important to start by putting the study into its temporal context. Just two months earlier, on December 31, 2019, health officials in Wuhan, China reported a cluster of cases involving an unknown pneumonia; a month earlier, on January 30, the World Health Organization (WHO) had declared the outbreak driven by this novel coronavirus (SARS-CoV-2) a Public Health Emergency of International Concern; February 12 a top CDC official announced it was discouraging general public use of masks to preserve scarce supplies for health care personnel, unless sick or potentially exposed; on the day of our survey's launch the CDC announced the first confirmed (on February 26 and 28) non-travel-related cases of human-to-human transmission in the U.S.; two weeks later (March 11) WHO declared the outbreak a pandemic; the likelihood of airborne (March 26) and asymptomatic (April 24) transmission, and official public health suggestions to wear cloth masks (April 3), arose still later

(Kupferschmidt 2020; on non-travel-related cases, Jorden et al. 2020; on mask-wearing, U.S. Centers for Disease Control and Prevention (USCDC) 2020). In other words, this was an extremely novel infection in the U.S. when we first surveyed our American sample, with high uncertainty in immunology, epidemiology and policy, and thus posing high uncertainty for the public on how to respond.

Multiple theories of behavior and behavior change have been applied to understand hazards-related behavior (e.g., the Health Belief Model, Becker 1974; Protection Motivation Theory, Rogers 1975; Theory of Planned Behavior, Ajzen 1985; the Extended Parallel Process Model, Witte 1992; Person relative to Event theory, Mulilis and Duval 1995). However, the Protective Action Decision Model (PADM) of Lindell and Perry (2004; 2012; Lindell 2018) is of particular interest here. As predictors of behavioral intentions it complements “threat perception” and “protective action perception” measures, which overlap with factors proposed in other models, with “stakeholder perception” measures that other models lack. These models are often applied to hazards in which agency is restricted primarily to individuals: e.g., health officials can provide information about the dangers of excessive sun tanning, but it is the potentially exposed who must decide whether and how to protect themselves. However, impersonal organizations and institutions can play a major role in management of infectious disease epidemics (e.g., by imposing quarantines or providing vaccination opportunities), as for many other hazards (e.g., nuclear power accidents). Stakeholder perceptions can affect behavioral intentions in diverse, often divergent

ways: e.g., trust in authorities might lead people to comply with their directives (e.g., shelter in place, evacuate) or reduce intentions to protect oneself on the assumption that authorities will take adequate protective action (e.g., Wachinger et al. 2013).

Thus, we began by assuming that higher threat (risk) perceptions, greater belief in certain attributes of protective actions (e.g., risk reduction efficacy) or of one's own response efficacy (e.g., resource sufficiency; Johnson 2019), and high trust in stakeholders would increase intentions to take a given protective action against the novel coronavirus. We followed Johnson (2019) in modifying the usual approach to testing the PADM (i.e., using a count of the number of protective actions adopted) by implementing a stages of behavior change measure (e.g., Weinstein 1988) for "intentions" so that we can distinguish people who have actually taken the protective action from those who intend to adopt it, are considering it, or have never heard of the action. PADM perceptions' predictive validity for Zika protective intentions differed across both behaviors and behavioral stages (Johnson 2019), suggesting the utility of this stages approach for understanding COVID protective action responses.

H1. *Intentions to adopt COVID-19 protective actions will increase as threat perceptions, action perceptions (risk reduction efficacy, resource sufficiency, utility for other purposes), and stakeholder perceptions (trust in government) increase.*

However, we also wanted to test whether and how the PADM might fit with other factors often explored in risk analysis. The model conceives of the threat, protective action, and stakeholder perceptions as generated through interaction of varied personal characteristics (e.g., resources, past experience with a hazard, demographics) and exposure and attention to, and comprehension of, varied information types (e.g., from environmental and social cues to messages from formal information sources). No empirical PADM study to date has tested these generic factors' effects on the three perceptions. By including measures upstream from perceptions, we can begin to explore which information and individual differences are pertinent for 2019-nCoV.

As predictors of threat perceptions, we posited the following:

H2. *As psychological distance increases, threat perceptions will decrease.*

Psychological distance (Liberman and Trope 2008)—i.e., whether the hazard seems distant or close in time, space, and effects on people like oneself, and uncertain or certain—has been examined particularly in risk analysis for its effects on climate change perceptions and communication, mostly finding that psychological proximity helps motivate pro-environmental behavior or policy support (Rickard et al. 2016). For Zika threat perceptions before exposure to information about the virus, seeing the threat as distant in time, space, and from people like oneself reduced both personal risk ratings and concern about local mosquito transmission of the virus, which then reduced intentions to adopt mosquito control behaviors; uncertainty had no effect (Johnson 2018). We expected a similar inverse relation between psychological distance from the coronavirus and threat perception, particularly given that we were analyzing beliefs from early in the pandemic's U.S. timeline.

When we turn to other predictors of PADM perceptions, we raise the question:

RQ1. *How do objective and subjective knowledge, relate to threat, action, and/or stakeholder perceptions?*

As little was yet known even by scientists about the virus and its control in late February 2020, we expected objective knowledge might amplify or attenuate these perceptions, per the Social Amplification of Risk Framework (Kasperson et al. 1988). Subjective knowledge may or may not be positively correlated with objective knowledge, but can have different, also unpredictable (positive or negative) associations with perceptions. For example, subjective and objective knowledge of genetically modified food in U.S., U.K., and French samples were correlated at $r=0.36$ ($p < .01$), but only subjective knowledge significantly predicted willingness to eat such food (House et al. 2004); by contrast, driver behavior given child pedestrians' presence was more associated with the low objective risk than the high subjective risk (Howarth 1988).

RQ2. *How does following of coronavirus news affect subjective or objective knowledge?*

We posited that coronavirus news following might shape both objective and subjective knowledge, given that the novelty of the virus and general absence of personal experience at this stage of the U.S. epidemic meant most people would get their information from traditional and/or social media. Although we suspect that news following might increase subjective knowledge, its effect on objective knowledge was less clear.

Other factors—e.g., culture (Douglas and Wildavsky 1982; Kahan 2012), conspiracist thinking (e.g., Swami et al. 2011); prejudice (e.g., Pettigrew and Meertens 1995); scientific deference (e.g., Brossard and Nisbet 2006), specific information sources (e.g., Wirz et al. 2020)—were also candidates, but were either not included in this initial wave of a longitudinal panel research design given instrument length constraints, needed to be assessed in relation to fuller measures (conspiracist, prejudice), or required more analysis (content of information sources) before they could be used effectively. We also avoided here looking at direct paths (e.g., from objective knowledge to intentions).

Based on available information at this early stage of the pandemic, the behavioral options we included were hand-washing, mask wearing, avoiding travel to infected areas, avoiding large public gatherings, and avoiding Chinese or people of Asian descent. These were either part of CDC advice, subject to official policy (primarily via travel bans, as self-isolation policies had not yet been imposed), or identified as issues in media reports (anti-Asian acts or avoidance).

Methods

We recruited 2004 American members of the Prolific online panel to answer a February 28, 2020 coronavirus survey, the day that the U.S. Centers for Disease Control and Prevention announced the first known cases of community (i.e., unrelated to travel, directly or indirectly) transmission of the novel coronavirus. This research was approved as exempt by the Decision Research Institutional Review Board, and subjects explicitly indicated their willingness to participate after reading the informed consent form.

The sample was 49.7% male, 48.9% female (1.4% choosing not to provide a gender), with a mean age of 35.31 (SD = 13.21). In terms of education, 54.7% of participants possessed a 4-year degree or higher. A sample majority identified as liberal (61.4%; 19.0% moderate, 19.5% conservative). Based on U.S. Census 2019 American Community Survey estimates, this sample was equally female, younger, and more educated than U.S. adults generally.

Table 1. Non-behavioral measures.

Label	Question	Answer options
News following	How closely are you following news about the coronavirus infections in China/the United States?	1 not at all, 2 not too closely, 3 somewhat closely, 4 very closely
Subjective knowledge	How much do you know about the coronavirus?	1 never heard of it, 2 heard of it but don't know any more, 3 know about it in general but not details, 4 know some details about it, 5 know a lot of details about it, 6 I am an expert on the coronavirus
Objective knowledge	Count of correctness of 15 original item responses (e.g., "Most people who get sick with the coronavirus recover")	1 true, 2 maybe true, 3 don't know, 4 maybe false, 5 false (reversed)
Psychological distance	Adaptation of 12 items tapping 4 (e.g., "The coronavirus will mostly affect areas far from here"; Spence et al. 2012)	1 strongly disagree, 2 somewhat disagree, 3 neither agree nor disagree, 4 somewhat agree, 5 strongly agree
COVID prevalence <i>Threat perceptions</i>	Coronavirus cases in county	Absolute number
Personal risk	How much risk does the coronavirus pose to you or your family, <i>if you or your family don't do anything</i> new to protect yourself against the coronavirus?	1 no risk, 2 slight risk, 3 some risk, 4 moderate risk, 5 high risk, 6 extreme risk
Concern	How concerned are you that the coronavirus will spread to where you live?	1 not at all concerned, 2 slightly concerned, 3 somewhat concerned, 4 moderately concerned, 5 highly concerned, 6 extremely concerned
US risk	How much risk does the coronavirus pose to the U.S.?	1 no risk, 2 slight risk, 3 some risk, 4 moderate risk, 5 high risk, 6 extreme risk
Global risk	How much risk does the coronavirus pose to the world?	1 no risk, 2 slight risk, 3 some risk, 4 moderate risk, 5 high risk, 6 extreme risk
<i>Protective action perceptions</i>		
Efficacy_H	This action will keep coronavirus risks low for my household	1 strongly disagree, 2 disagree, 3 somewhat disagree, 4 somewhat agree, 5 agree, 6 strongly agree
Efficacy_C	This action will keep coronavirus risks low for vulnerable people in my community not in my household	1 strongly disagree, 2 disagree, 3 somewhat disagree, 4 somewhat agree, 5 agree, 6 strongly agree
Relevance	This action is/is NOT relevant to my household	NA
Utility	This action will be useful for purposes other than protecting against the coronavirus	1 strongly disagree, 2 disagree, 3 somewhat disagree, 4 somewhat agree, 5 agree, 6 strongly agree
Resource sufficiency	My household has the time, money, skills and/or other resources needed to take this action	1 strongly disagree, 2 disagree, 3 somewhat disagree, 4 somewhat agree, 5 agree, 6 strongly agree
<i>Stakeholder perceptions</i>		
Trust CDC	Please rate how much you trust the CDC to help protect Americans from the coronavirus	1 no trust, 2 slight trust, 3 some trust, 4 moderate trust, 5 high trust, 6 extreme trust
Trust WHO	Please rate how much you trust the World Health Organization (WHO) to help protect Americans from the coronavirus	1 no trust, 2 slight trust, 3 some trust, 4 moderate trust, 5 high trust, 6 extreme trust
Trust Trump	Please rate how much you trust the Office of the President (including staff people) to help protect Americans from the coronavirus	1 no trust, 2 slight trust, 3 some trust, 4 moderate trust, 5 high trust, 6 extreme trust

Measures excluding behavioral intentions appear in Table 1. Threat, protective action, and stakeholder perceptions were latent variables measured by several items each. The conditional phrasing of the personal risk item used here follows Brewer et al. (2004), who proposed that conventional risk perception measures (i.e., without the second

Table 2. Behavioral intention percentages.

n = 2002	Decided Against†	Never considered	Considering	Decided For (Intention)	Have Taken	Maintaining
Hand wash	0.2%	2.1%	4.3%	5.5%	12.3%	75.6%
Face mask	11.1%	47.5%	32.2%	3.2%	3.0%	3.1%
Avoid travel	1.2%	29.4%	14.2%	14.2%	9.8%	31.2%
Avoid public gatherings	6.4%	35.0%	33.1%	8.1%	6.3%	11.0%
Avoid Asians	6.9%	74.0%	9.4%	3.4%	2.3%	3.9%

†Removed from further analysis to allow creation of an ordinal intentions index

Table 3. Correlation matrix of behavioral intentions.

	Wash hands	Wear mask	Avoid travel	Avoid public gatherings
Wash hands				
Wear mask	0.05*			
Avoid travel	0.14***	0.22***		
Avoid public gatherings	0.13***	0.37***	0.31***	
Avoid Asians	−0.01	0.32***	0.25***	0.36***

* $p < .05$ *** $p < .001$

clause) could confound risk perceptions with behavioral intentions, when here we want to predict the latter with the former. U.S. and global risk perceptions also were measured. Besides concern, we included other affective measures (how very bad-very good the coronavirus makes you feel; how much do you dread it; likelihood of a large outbreak in the U.S. in the next five years), but given high inter-item correlations their addition decreased model fit. Protective action perceptions employed here included how effective the behavior was deemed to be for reducing risk to the household and to the vulnerable members of the community, and how much the behavior was thought to protect against other hazards, found to increase behavior adoption. Relevance, utility, and resource sufficiency also were measured, but their inclusion in action perception also reduced model fit.

Behavioral intentions were elicited for five protective actions, specifying that “My household” has never considered taking this action, is considering it, decided to take this action, has taken this action, or has taken this action and will continue to take this action as needed. The distribution of these intentions is displayed in Table 2. The answer “decided against taking this action” is omitted for this analysis, to provide an ordinal response scale, thus sub-samples varied in size and did not equal the total sample size. Behaviors were washing hands with soap and warm water many times a day ($n = 1990$), wearing a mask when going out in public ($n = 1775$), avoiding travel to infected areas in China or other countries, including U.S. areas where people have been infected ($n = 1967$), avoiding large public gatherings (including formal organized events such as concerts, sports events, or fairs, or informal gatherings like going to the mall, school, work or other places where lots of people happen to be; $n = 1870$); and avoiding people from China or other Asian countries ($n = 1857$). The Pearson correlations among these intentions are displayed in Table 3.

Analyses were structural equation models estimated using R version 3.6.3 and package lavaan version 0.6. Models were estimated using maximum likelihood estimation. All parameter estimates presented are standardized.

Table 4. Descriptive Statistics for Model Variables.

N = 2002	Mean (SD)	Median	Minimum	Maximum
Trust in the CDC	4.18 (1.22)	4	1	6
Trust in WHO	4.03 (1.29)	4	1	6
Trust in the Office of the President	2.20 (1.46)	2	1	6
Psychological Distance	3.31 (0.47)	3.33	1.67	4.58
Objective Knowledge	3.60 (0.40)	3.6	2.2	4.73
Subjective Knowledge	4.04 (0.63)	4	1	6
Personal Risk Perception	2.79 (1.10)	3	1	6
US Risk Perception	3.67 (1.16)	4	1	6
Global Risk Perception	4.30 (1.11)	4	1	6
Affect	23.98 (16.16)	23	0	100
<i>Keeps household risks low</i>				
Wash hands	4.99 (1.00)	5	1	6
Wear mask	3.54 (1.41)	4	1	6
Avoid travel	4.93 (1.21)	5	1	6
Avoid public	4.28 (1.24)	4	1	6
Avoid Asians	2.66 (1.54)	2	1	6
<i>Keeps community risks low</i>				
Wash hands	4.86 (1.14)	5	1	6
Wear mask	3.75 (1.42)	4	1	6
Avoid travel	4.84 (1.26)	5	1	6
Avoid public	4.31 (1.27)	4.50	1	6
Avoid Asians	2.66 (1.54)	2	1	6
<i>Useful for other purposes</i>				
Wash hands	5.31 (1.09)	6	1	6
Wear mask	3.27 (1.53)	3	1	6
Avoid travel	2.87 (1.66)	3	1	6
Avoid public	3.25 (1.53)	3	1	6
Avoid Asians	1.86 (1.21)	1	1	6

Table 5. Convergence and model fit statistics.

	Model Convergence, $\chi^2(89)$	CFI	TLI	RMSEA (90% CI)	R ²
Wash hands	880.97	.908	.879	(.063–.071)	11.6%
Wear mask	713.56	.927	.905	(.059–.063)	27.6%
Avoid travel	798.40	.917	.890	(.060–.068)	17.5%
Avoid public	777.52	.920	.894	(.060–.069)	24.6%
Avoid Asians	739.13	.944	.926	(.059–.067)	24.6%

The model was built as postulated in the Protective Action Decision Model (PADM) of Lindell and Perry (2012), plus the upstream variables discussed above. In this model, behavioral intentions are predicted by the latent variables of action perceptions, stakeholder perceptions, and threat perceptions. Action perceptions and stakeholder perceptions are predicted by knowledge (objective and subjective). Threat perceptions are predicted by knowledge indicators and perceived psychological distance. Lastly, knowledge indicators are predicted by US and Chinese news following. Descriptive statistics for all variables included in the models (for the entire sample) are displayed in Table 4.

Results

All five models converged normally (Table 5). Model fit was modest by CFI and TLI statistics, but good for RMSEA. Proportion of variance explained by the model was modest, from 12% to 25% across the five behavior models.

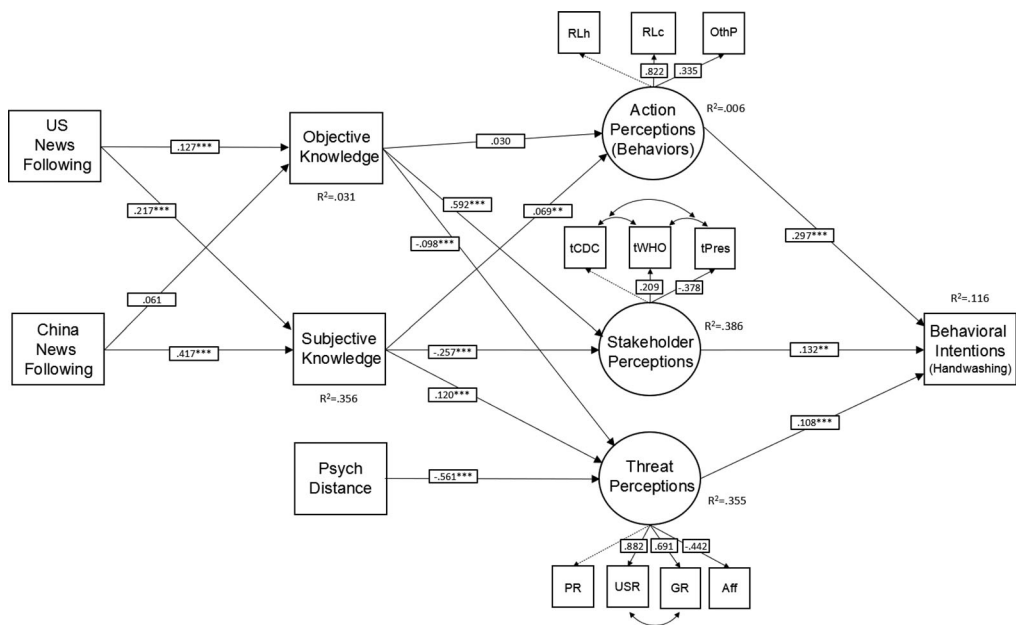


Figure 1. SEM model of handwashing intention.

Because the only potential variance across these five models occurs in action perceptions and behavioral intentions—the other measured variables do not differ across behaviors—most links exhibit similar coefficients across the five models. Thus we summarize these first, before discussing outlier results. Going from left to right in the original model (Figures 1–5 provide the model for each of the behavioral intentions), following news about the coronavirus had a stronger effect on subjective than objective knowledge, but the gap was much greater for China news following than for U.S. news following. This suggests that even at this early stage of the U.S. pandemic people were paying more attention to coverage of the U.S. experience than to events elsewhere. Stakeholder perceptions collectively were strongly and positively associated with objective knowledge (with weaker links for avoiding public gatherings and mask-wearing), but only moderately and negatively associated with subjective knowledge (i.e., as subjective knowledge increased, trust declined). Threat perceptions were lower for those high in objective knowledge and who rated the virus as psychologically distant, but higher for those high in subjective knowledge. Action perceptions (particularly for Asian-avoidance and mask-wearing) were largely negatively associated with objective knowledge, and weakly but positively associated with subjective knowledge. Variance explained was very low for objective knowledge and action perceptions, high (> 0.350) and consistent for subjective knowledge and threat perception, quite variable for stakeholder perception ($> .380$ for handwashing, and avoiding Asians and travel; $\leq .200$ for mask-wearing and avoiding public gatherings), and generally low but variable for behavioral intentions (.116 handwashing, to .331 avoid Asians).

Action perceptions were only weakly, and mainly positively, associated with subjective knowledge (Figures 1–5). They were mostly weakly and mostly negatively

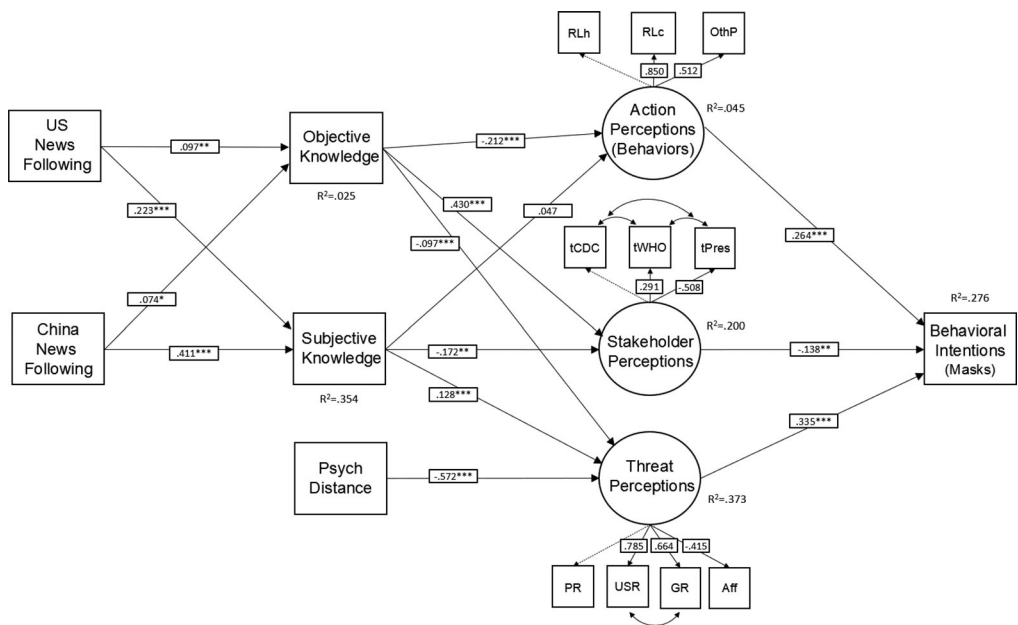


Figure 2. SEM model of mask-wearing intention.

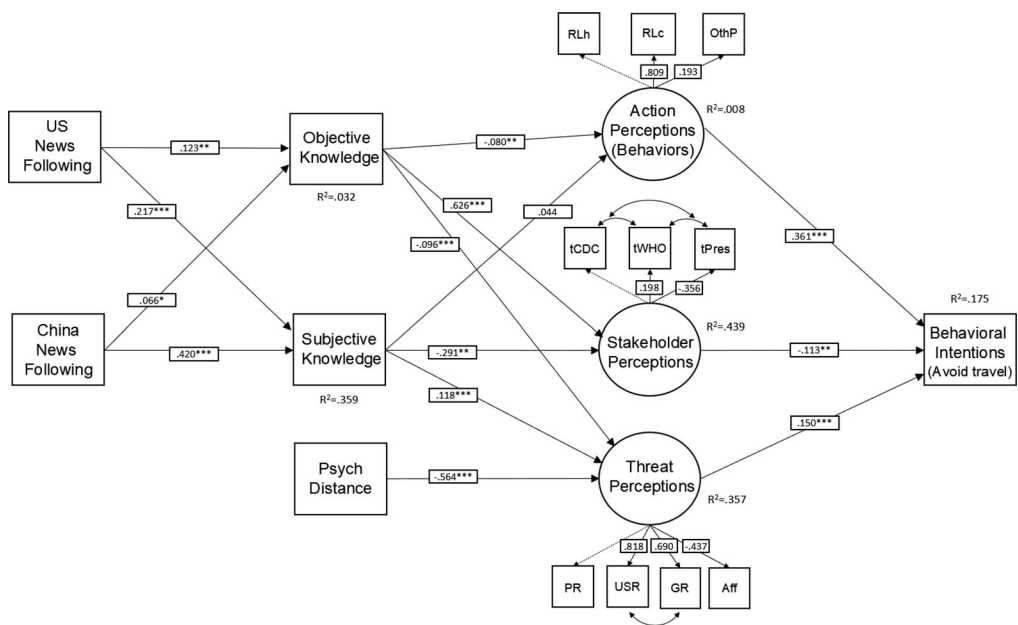


Figure 3. SEM model of avoiding travel intention.

associated with objective knowledge, but stronger effects occurred for mask wearing and Asian-avoiding: the more objective knowledge people had, the less likely they were to rate these two actions as efficacious at reducing risk. Note that at this time U.S. health officials were downplaying the efficacy of mask-wearing for protecting

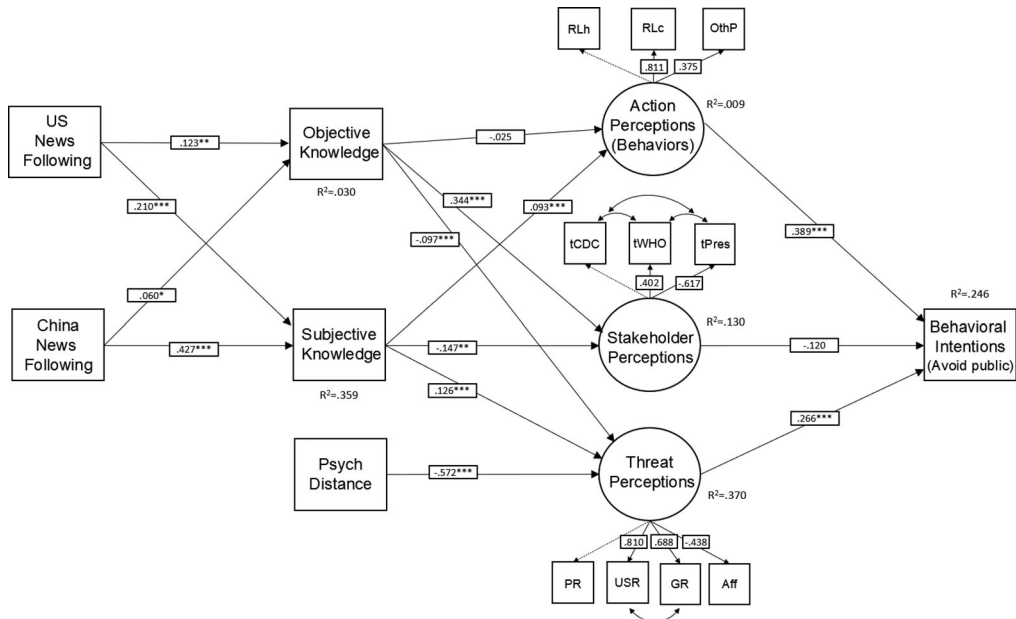


Figure 4. SEM model of avoiding large public gatherings intention.

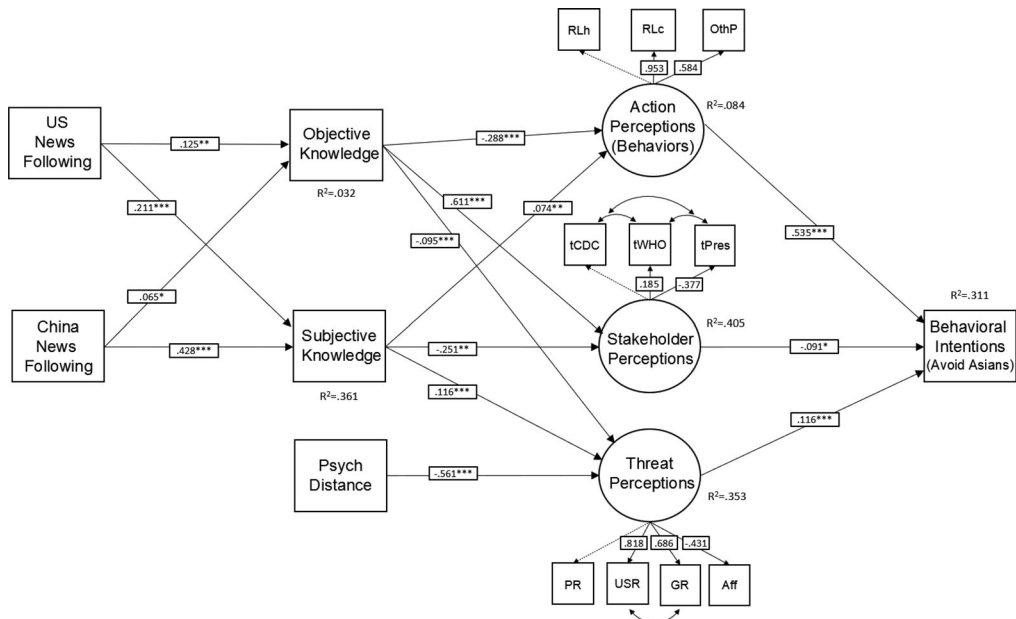


Figure 5. SEM model of avoiding Asians intention.

oneself, out of concern for a run on N95 masks needed for those caring for those with COVID-19.

As for PADM variables, action perceptions exhibited expected positive associations with all five behavioral intentions, particularly strong for avoiding Asians, and weaker for mask-wearing and handwashing. Threat perceptions also were positively associated with intentions, but more strongly for handwashing and avoiding public gatherings, and weakly for mask-wearing and Asian avoidance. Stakeholder perceptions were modestly associated with intentions, all negatively (more trust led to lower intentions) except for hand-washing.

Overall, the original model did a moderately good job of predicting behavioral intentions, with action and threat perceptions positively and stakeholder perceptions negatively associated with such intentions.

Discussion

Our main findings were consistent with our two hypotheses: greater threat, stakeholder and action perceptions increased behavioral intentions (H1), and psychological distance reduced threat perceptions (H2). As for our research questions, objective knowledge reduced threat and action perceptions, and increased trust, while subjective knowledge increased threat and action perceptions, but reduced trust in stakeholders (RQ1); and news following increased both objective knowledge and subjective knowledge, with stronger effects on subjective knowledge and for US news following (RQ2).

Overall model fit was adequate but not stellar, and explained variance was moderate. Although the general patterns were similar across actions—only two latent variables, action perceptions and behavioral intentions, could vary across actions—there was enough variation in magnitude and sometimes sign, and in explained variance, to underline the value of analyzing each protective behavior on its own. Although we did not deploy the PADM perceptions on their own as predictors here, as in Johnson (2019), both studies found that the usual approach in natural hazards studies (including those using the PADM) of calculating protective action as a sum of behaviors adopted does not adequately reflect the variability in responses across actions.

These results have varying implications. On the one hand, model fit and variance explained in behavioral intentions are moderate at best for these five behaviors, which raises questions about how complete this model is. As we noted earlier, we did not include even all of the possible predictors that we had considered, primarily because those data were not yet available (e.g., they were planned for future waves of data collection, or required intensive content analysis not yet feasible to undertake). So we should not take the current model as the final word on explaining coronavirus-related behavior. On the other hand, a potentially sub-optimal model fits quite well, and particularly so given that this survey occurred so early in the US experience of the COVID-19 pandemic. The number of US coronavirus cases—not deaths, simply instances of infection—when the survey was launched was in the low double digits, compared to the over 25 million cases in late January 2021. Unfortunately, we do not have enough longitudinal studies—much less longitudinal panel studies, in which the same people are interviewed repeatedly—of responses to epidemics to know clearly whether we should expect different models to fit differently depending upon whether they model an early or middle or late stage of an epidemic. For example, longitudinal panel studies of

factors in US threat perceptions (therefore not behaviors, as here) found that Ebola and Zika predictors were almost the same at baseline (wave 1 of the respective panel studies), but individual differences had much greater effect on downward trends in threat perception for Ebola than for Zika (Mayorga and Johnson 2019; Johnson and Mayorga 2020). Given that both diseases in the US were far less prevalent than COVID-19, and the analytic endpoint was threat perception rather than behavioral intentions, this comparison can only underline the need to account for variation in model aims, model predictors, and explanatory targets.

Objective and subjective knowledge's opposite associations with threat, action, and stakeholder perceptions merit attention, as these two types of knowledge are not always so neatly contrasted. Given the early timing in the pandemic of this survey, and the then-current CDC warning against face masks being personally protective so as to reserve the most effective masks for frontline health care workers, it seems plausible that at this point people who were following the coronavirus news and were educated tended to trust public health agencies to deal with COVID-19, discounted the threat, and were more skeptical about the risk-reduction efficacy of these behaviors. We suspect that this contrast might change if tested again later during the pandemic.

Limitations of this study extend beyond its data from very early in the pandemic's development and use of a parsimonious model. For example, the PADM has used measures of expertise (one hypothesized factor in some trust models), responsibility (i.e., who is expected to protect the respondent, such as government), and trustworthiness as measures of stakeholder perceptions, while for both space and theoretical reasons (e.g., the overlap between judged expertise and trust) we limited our measure to trust in public health agencies (Centers for Disease Control and Perception; World Health Organization) and the Office of the President. As noted earlier, we assessed self-reported news following, but have not (yet) examined influence of the content of the specific legacy and social media outlets that people reported using. And we have not yet applied this model to longitudinal data to see if model fit becomes stronger or weaker when accounting for temporal changes. This study of American views cannot generalize to non-US samples.

Conclusion

This study illustrated that even early in an epidemic of a novel pathogen—weeks before the World Health Organization declared a pandemic—a parsimonious model involving threat, action and stakeholder perceptions, objective and subjective knowledge, psychological distance, and news following was able to do an adequate job of predicting intentions to perform five protective behaviors, including four that have been recommended by public health officials *and* one deemed ineffective and misleading (avoiding Asians). This is not to say that adding variables or collecting data later in the pandemic would not strengthen model fit, but parsimony is valuable for purposes both practical (e.g., improving risk communication) and theoretical (e.g., the objective efficacy of a protective behavior does not determine the predictive validity of the model). Further testing of this model in other societies, or for other diseases, would advance our understanding of public response to infectious diseases.

Acknowledgments

This research was supported by the U.S. National Science Foundation under Grant No. 2022216.

Disclosure statement

The authors declare they have no financial interest or benefit that has arisen from this research.

ORCID

Branden B. Johnson  <http://orcid.org/0000-0003-2264-5419>

Marcus Mayorga  <http://orcid.org/0000-0001-5471-0655>

References

- Ajzen I. 1985. From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckmann, editor. *Action control: From cognition to behavior*. Berlin, Heidelberg, New York: Springer-Verlag; p. 11–39.
- Becker MH. 1974. The Health Belief Model and personal health behavior. *Health Education Monographs*. 2(4):409–508. doi:[10.1177/109019817400200407](https://doi.org/10.1177/109019817400200407)
- Brossard D, Nisbet MC. 2006. Deference to scientific authority among a low information public: Understanding U.S. opinion on agricultural biotechnology. *International Journal of Public Opinion Research*. 19 (1):24–52. doi:[10.1093/ijpor/edl003](https://doi.org/10.1093/ijpor/edl003)
- Brewer NT, Weinstein ND, Cuite CL, Herrington J. 2004. Risk perceptions and their relation to risk behavior. *Annals of Behavioral Medicine*. 27: 125–130.
- Douglas M, Wildavsky A. 1982. *Risk and culture: An essay on the selection of technical and environmental dangers*. Berkeley, CA: University of California Press.
- Flora DB. (2020). Your coefficient alpha is probably wrong, but which coefficient omega is right? A tutorial on using R to obtain better reliability estimates. *Advances in Methods and Practices in Psychological Science*. 3(4):484–501.
- House L, Lusk J, Jaeger S, Traill WB, Moore M, ... , Yee WMS. 2004. Objective and subjective knowledge: Impacts on consumer demand for genetically modified foods in the United States and the European Union. *AgBioForum*. 7(3):113–123.
- Howarth CI. 1988. The relationship between objective risk, subjective risk and behaviour. *Ergonomics*. 31(4):527–535. doi:[10.1080/00140138808966697](https://doi.org/10.1080/00140138808966697)
- Johnson BB. 2018. Residential location and psychological distance in Americans' Risk Views and Behavioral Intentions Regarding Zika Virus. *Risk Anal*. 38(12):2561–2579. doi:[10.1111/risa.13184](https://doi.org/10.1111/risa.13184)
- Johnson BB. 2019. Americans' Views of Voluntary Protective Actions Against Zika Infection: Conceptual and Measurement Issues. *Risk Anal*. 39(12):2694–2717. doi:[10.1111/risa.13378](https://doi.org/10.1111/risa.13378)
- Johnson BB, Mayorga M. 2020. Temporal shifts in Americans' risk perceptions of the Zika outbreak. *Human and Ecological Risk Assessment*. early online publication, DOI doi:[10.1080/10807039.2020.1820852](https://doi.org/10.1080/10807039.2020.1820852)
- Jorden MA, Rudman SL, Villarino E, Hoferka S, Patel MT, Bemis K, Simmons CR, Jespersen M, Iberg Johnson J, Mytty E, CDC COVID-19 Response Team, et al. 2020. Evidence for limited early spread of COVID-19 within the United States, January-February 2020. *MMWR Morb Mortal Wkly Rep*. 69(22):680–684. doi:[10.15585/mmwr.mm6922e1](https://doi.org/10.15585/mmwr.mm6922e1)
- Kahan DM. 2012. Cultural cognition as a conception of the cultural theory of risk. In S. Roeser, R. Hillerbrand, P. Sandin, & M. Petersen, editor, *Handbook of risk theory: Epistemology, decision theory, ethics, and social implications of risk*. Dordrecht, The Netherlands: Springer; p. 725–759.

- Kasperson RE, Renn O, Slovic P, Brown HS, Emel J, Goble R, Kasperson JX, Ratick S. 1988. The social amplification of risk: A conceptual framework. *Risk Anal.* 8(2):177–187. doi:[10.1111/j.1539-6924.1988.tb01168.x](https://doi.org/10.1111/j.1539-6924.1988.tb01168.x)
- Kupferschmidt K. 2020. A divisive disease. *Science*. 370(6523):1395–1397. doi:[10.1126/science.370.6523.1395](https://doi.org/10.1126/science.370.6523.1395)
- Lieberman N, Trope Y. 2008. The psychology of transcending the here and now. *Science*. 322(5905):1201–1205. doi:[10.1126/science.1161958](https://doi.org/10.1126/science.1161958)
- Lindell MK. 2018. Communicating imminent risk. In Rodriguez, H., Trainor, J., & Donner, W. editor, *Handbook of Disaster Research*. New York: Springer; p. 449–477.
- Lindell MK, Perry RW. 2004. *Communicating environmental risk in multiethnic communities*. Thousand Oaks CA: Sage.
- Lindell MK, Perry RW. 2012. The Protective Action Decision Model: Theoretical modifications and additional evidence. *Risk Anal.* 32(4):616–632. doi:[10.1111/j.1539-6924.2011.01647.x](https://doi.org/10.1111/j.1539-6924.2011.01647.x)
- Mayorga MW, Johnson BB. 2019. A longitudinal study of concern and judged risk: The case of Ebola in the United States, 2014–2015. *Journal of Risk Research*. 22(10):1280–1293. doi:[10.1080/13669877.2018.1466827](https://doi.org/10.1080/13669877.2018.1466827)
- Mulilis JP, Duval TS. 1995. Negative threat appeals and earthquake preparedness: A person-relative-to-event (PrE) model of coping with threat. *J Appl Social Psychol.* 25(15):1319–1339. doi:[10.1111/j.1559-1816.1995.tb02620.x](https://doi.org/10.1111/j.1559-1816.1995.tb02620.x)
- Pettigrew TF, Meertens RW. 1995. Subtle and blatant prejudice in western Europe. *Eur J Soc Psychol.* 25(1):57–75. [Database] doi:[10.1002/ejsp.2420250106](https://doi.org/10.1002/ejsp.2420250106)
- Rickard LN, Yang ZJ, Schuldt JP. 2016. Here and now, there and then: How “departure dates” influence climate change engagement. *Global Environ Change.* 38:97–107. doi:[10.1016/j.gloenvcha.2016.03.003](https://doi.org/10.1016/j.gloenvcha.2016.03.003)
- Rogers RW. 1975. A protection motivation theory of fear appeals and attitude Change1. *J Psychol.* 91(1):93–114. doi:[10.1080/00223980.1975.9915803](https://doi.org/10.1080/00223980.1975.9915803)
- Spence A, Poortinga W, Pidgeon NF. 2012. The psychological distance of climate change. *Risk Analysis.* 32(6):957–972. doi:[10.1111/j.1539-6924.2011.01695.x](https://doi.org/10.1111/j.1539-6924.2011.01695.x)
- Swami V, Coles R, Stieger S, Pietschnig J, Furnham A, Rehim S, Voracek M. 2011. Conspiracist ideation in Britain and Austria: Evidence of a monological belief system and associations between individual psychological differences and real-world and fictitious conspiracy theories. *Br J Psychol.* 102(3):443–463. doi:[10.1111/j.2044-8295.2010.02004.x](https://doi.org/10.1111/j.2044-8295.2010.02004.x)
- U.S. Centers for Disease Control and Prevention (USCDC). 2020. *Transcript for CDC telebriefing: CDC update on novel coronavirus* (12 February). <https://www.cdc.gov/media/releases/2020/t0212-cdc-telebriefing-transcript.html>, downloaded 19 January 2021.
- Wachinger G, Renn O, Begg C, Kuhlicke C. 2013. The risk perception paradox-implications for governance and communication of natural hazards. *Risk Anal.* 33(6):1049–1065. doi:[10.1111/j.1539-6924.2012.01942.x](https://doi.org/10.1111/j.1539-6924.2012.01942.x)
- Weinstein ND. 1988. The precaution adoption process. *Health Psychology.* 7(4):355–386. doi:[10.1037/0278-6133.7.4.355](https://doi.org/10.1037/0278-6133.7.4.355)
- Wirz CD, Mayorga M, Johnson BB. 2020. A longitudinal analysis of Americans’ media sources, risk perceptions, and judged need for action during the Zika outbreak. *Health Communication*. early online publication, [10.1080/10410236.2020.1773707](https://doi.org/10.1080/10410236.2020.1773707).
- Witte K. 1992. Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs.* 59(4):329–349. doi:[10.1080/03637759209376276](https://doi.org/10.1080/03637759209376276)