Technical Note

Perceptions of Efficacy are Key Determinants of Mask-Wearing Behavior during the COVID-19 Pandemic

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Abstract: Public health officials recommend wearing a mask to reduce the spread of COVID-19, yet individual compliance varies. Understanding the full range of determinants of mask-wearing is critical for promoting evidence-based public health solutions to slow the spread of COVID-19. Using data from a survey of 3,059 respondents across six US states, this study investigates the relationship between psychological factors, including threat- and efficacy-related perceptions, on mask-wearing behavior. It is found that respondents' perceptions of self-efficacy (e.g., ability to wear a mask) and response efficacy (e.g., effectiveness of mask-wearing in reducing COVID-19 transmission) better predict mask-wearing behavior than a number of commonly cited sociodemographic factors. These results suggest that messaging focused on the relative ease and effectiveness of mask wearing may help increase compliance with public health recommendations for mitigating COVID-19. **DOI: 10.1061/(ASCE)NH.1527-6996.0000489.** © *2021 American Society of Civil Engineers.*

Introduction

To limit transmission of the COVID-19 virus, public health officials recommend wearing a mask or other facial covering indoors, particularly when it is difficult to maintain 1.8 m (6 ft) of distance from others (Centers for Disease Control and Prevention 2020; WHO 2020a). Despite evidence for the effectiveness of masks in reducing viral spread (Brooks et al. 2020; Eikenberry et al. 2020), mask-wearing behavior varies across groups. For example, those who self-identify as women, Democrats, and urban residents are more likely to wear masks than individuals in other sociodemographic groups (Brenan 2020; National Geographic 2020; Haischer et al. 2020). Additionally, social factors, such as the risk of racial profiling and its potentially lethal consequences, may discourage mask-wearing among people of color, particularly African American men (Wolpert 2020).

Emerging research has also begun to investigate the impact of various psychological factors on mask-related perceptions and behaviors during the COVID-19 pandemic. Kasting et al. (2020) found that individuals who are more worried about COVID-19 are also more likely to perceive mask-wearing as an effective behavior in reducing the spread of COVID-19. However, those who perceive that they are highly susceptible and likely to experience severe COVID-19 outcomes perceive lower effectiveness, perhaps due to a sense of fatalism. These insights are particularly important given that other research suggests individuals who believe in the beneficial effects of risk-reduction behaviors like mask-wearing are indeed more likely to engage in those behaviors (Hornik et al. 2021). Other scholars also found that higher risk perceptions (Dryhurst et al. 2020) and higher levels of risk aversion (Xu and Cheng 2021) are positively associated with higher reported rates of mask-wearing and other protective behaviors.

To better understand the impact of these types of psychological factors on mask-wearing, including how they may interact to produce different behavioral outcomes, this study uses the extended parallel process model (EPPM) (Witte 1994). EPPM hypothesizes that if a person believes they are particularly susceptible to a high-severity threat and that they can mitigate that threat effectively, then they are more likely to engage in recommended risk-reduction behaviors (Popova 2012). Effective mitigation includes two elements: (1) self-efficacy, or the ability to engage in the behavior, and (2) response efficacy, or the belief that the behavior will indeed mitigate risk. Conversely, when either threat- or efficacy-related perceptions are low, individuals may be less likely to engage in the risk-reduction behavior, potentially because they are avoiding or in denial of their risk. Using survey data from a representative sample of respondents ($n = 3{,}059$) in six US states, this study investigates relationships among these psychological factors, sociodemographic characteristics, and mask-wearing. Understanding the full range of mask-wearing determinants is critical for promoting evidence-based public health measures that can slow the spread of COVID-19.

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Data and Methods

The authors conducted an internet survey between May 12 and June 7, 2020, that was funded by the US National Science Foundation, approved by Bentley University's Institutional Review Board, and administered by the online survey firm Qualtrics XM to a proprietary online sample of respondents in six US states: Colorado, Iowa, Louisiana, Massachusetts, Michigan, and Washington. These states were selected at a watershed moment in the COVID-19 pandemic (April 2020) to capture geographic variation in the onset of the COVID-19 outbreak, risk-reduction policies, and demographic and social factors (further details on the context of each state at the time these data were collected are included in Risk and Social Policy Working Group (2020). At that time, COVID-19 had killed about 100,000 people in the US and infected over 2 million. Despite different and evolving state and local-level policies related to mask-wearing (Lyu and Wehby 2020), and inconsistent messaging around masks (Greenhalgh et al. 2020; Quinn 2020), public health officials recommended that all individuals, including those who are asymptomatic, always wear a mask in indoor public spaces at the time of this survey. Most states had also implemented stay-at-home orders and began developing plans for a phased reopening of businesses at this time, despite warnings that the pandemic was likely to worsen.

The age, race, and income distributions of the survey sample closely matched each state's population distributions, according to data from the US Census. However, because of difficulties meeting multiple sampling quotas simultaneously, the sample included a higher proportion of females than males in all states, which is thus controlled for in the analyses. Overall, respondents were 60.08% female, 39.33% male, and 0.39% other. The majority of respondents were White (70.81%), and 39.42% of respondents had an income over $80,000 per year (with 10.59% of those making over $150,000 per year). The sample was somewhat evenly split by political ideology, with 30.5% of respondents identifying as liberal, 38.74% identifying as moderate, and 30.76% identifying as conservative.

After providing consent to be involved in the survey, respondents were asked about their risk perceptions, risk-reduction behaviors, and demographics. Central to this analysis, respondents were asked how frequently they wore a mask in indoor public spaces (e.g., a store or work) over the last week. Of 3,059 total survey respondents, 2,863 (93.59%) responded to this question and are included in the subsequent analyses. A portion of respondents ($n = 196$) reported Not Applicable, suggesting they did not visit indoor public spaces.

Respondents were also asked about their perceptions of threat related to the COVID-19 pandemic, as well as efficacy related to mask-wearing as a way to reduce risk. In line with the EPPM, threat perceptions included perceived susceptibility (measured as likelihood of contracting COVID-19) and perceived severity (measured as an average of likelihood of becoming severely ill or dying if infected). Efficacy perceptions included perceived self-efficacy (measured as confidence in one's ability to wear a mask) and perceived response efficacy (measured as an average of confidence in the effectiveness of masks to protect one's self and others).

Table 1 includes the question text, response options, and descriptive statistics for the independent and outcome variables. Importantly, these questions were developed as part of a comprehensive survey approximately 2 months into the pandemic in the US, and although the research team made every attempt to develop questions using measures from other contexts, measuring each of these constructs through multiple validated measures was not always possible. The sociodemographic variables included in this analysis are listed in Table 2.

Analysis and Results

The majority of survey respondents reported owning a mask or face covering ($n = 2{,}921$, 95.49%), with cloth reported as the most common fabric ($n = 1{,}726$, 56.4%), indicating that the vast majority of respondents could wear a mask if they chose to do so. When asked about mask-wearing behavior, over half of survey respondents ($n = 1{,}893$, 66.1%) reported always wearing a mask in indoor public spaces, whereas the remaining respondents reported wearing a mask sometimes ($n = 568$, 18.6%) or never ($n = 402$, 14.0%). Although a self-reported measure of mask-wearing may be subject to social desirability bias, respondents were informed that their responses were anonymous and that they could skip survey

Table 1. Concepts, variables, and measures for dependent and independent variables

Concept	Variable	Questions	Response options	Descriptive statistics
Risk-reduction behavior	Mask-wearing	In the past week, how often did you wear a face covering when in an indoor space that is not your home (for example, at a store or at work)	Never Sometimes Always	14.04% 19.84% 66.12%
Threat	Perceived susceptibility	On a scale of 0%–100%, what do you think is the chance that you will get COVID-19 in the next three months?	Sliding scale: 0%–100%	Mean: 27.76% Standard deviation: 0.42
	Perceived severity[a]	If you do get COVID-19, what is the chance that you will become seriously ill?	Sliding scale: 0%–100%	Mean: 34.03% Standard deviation: 0.49
		If you do get COVID-19, what is the chance that you will die from it?	Sliding scale: 0%–100%	Mean: 21.76% Standard deviation: 0.46
Efficacy	Self-efficacy	I am able to wear a face covering	5-point Likert scale: Strongly Agree to Strongly Disagree	Mean: 4.30 Standard deviation: 0.02
	Response efficacy[b]	How effective do you think wearing a face covering is to prevent you from getting COVID-19?	5-point Likert scale: Completely ineffective to Completely effective.	Mean: 3.36 Standard deviation: 0.02
		How effective do you think wearing a face covering is to prevent you from spreading COVID-19 to other people?		Mean: 3.70 Standard deviation: 0.02

[a]Cronbach's alpha = 0.79, Pearson's correlation coefficient = 0.66.
[b]Cronbach's alpha = 0.87, Pearson's correlation coefficient = 0.77.

Table 2. Ordinal logistic regression results from models predicting mask wearing indoors (never, sometimes, or always)

Variable category	Variable name	Model 1	Model 2	Model 3
Sociodemographics	Has children	−0.13	−0.12	−0.12
	Male	−0.10	−0.13	−0.12
	Race: compared to white			
	Black	0.39***	0.20	0.20
	Latinx	0.14	−0.017	−0.011
	Asian	0.55**	0.31	0.31
	Other race/multiracial	0.53**	0.40	0.41*
	Age: compared to 18–34			
	Age 35 to 55	0.068	0.17	0.18*
	Age 55+	0.62***	0.49***	0.50***
	Education: compared to high school or lower			
	Some college	0.26**	0.20	0.20
	College degree	0.42***	0.30**	0.31***
	Graduate degree	0.71***	0.49***	0.49***
	Income: compared to under $40K			
	Income $40K to $80K	0.052	0.036	0.029
	Income $80K to $150K	0.25**	0.096	0.088
	Income over $150K	0.031	−0.083	−0.089
	Political ideology: compared to moderate			
	Liberal	0.49***	0.27**	0.28**
	Conservative	−0.24**	0.014	0.039
	States: compared to Colorado			
	Iowa	−0.94-***	−0.93***	−0.93***
	Louisiana	−0.71***	−0.72***	−0.72***
	Massachusetts	0.69***	0.55***	0.55***
	Michigan	0.022	0.17	0.18
	Washington	−0.66***	−0.58***	−0.59***
EPPM	Self-efficacy	—	0.60***	0.64***
	Response efficacy	—	0.45***	0.47***
	Susceptibility	—	0.031	0.020
	Severity	—	0.071***	0.16***
	Severity^2 × self-efficacy × response efficacy	—	—	−0.00077
Observations		2,863	2,863	2,863
PseudoR^2		0.07	0.17	0.17
Akaike information criterion (AIC)		4,695.8	4,192.9	4,185.9

Note: Model 1 includes sociodemographic variables only. Model 2 adds EPPM variables. Model 3 includes an interaction between threat severity and efficacy variables. Results reported are regression coefficients: positive (negative) coefficients indicate a positive (negative) association between the variable and mask wearing frequency. * = significant at the 10% level; ** = significant at the 5% level; and ***= significant at the 1% level.

questions, which the authors believe appropriately mitigated this potential bias.

Fig. 1 plots the marginal effects from ordinal logistic regressions for two models. Model 1 predicts the probability that an individual always wears a mask in indoor public spaces based on sociodemographic variables only, and Model 2 includes both sociodemographic and EPPM variables as predictors. Table 2 displays the coefficient estimates for each of these models, as well as a third model with an interaction term that will be discussed in more detail subsequently. Model 1 reveals that Black, Asian, and other non-White respondents are 8 to 11 percentage points more likely than White respondents to always wear masks in indoor public spaces. Respondents with a 2019 household income between $80,000 and $150,000 are 5 percentage points more likely to always wear a mask than respondents making less than $40,000.

When EPPM variables are added to the analysis, Model 2 shows that respondents who perceive higher self-efficacy, higher response efficacy, and higher threat severity are more likely to wear a mask. A one-unit increase in perceived self-efficacy is associated with a 10-percentage-point increase in the probability of always wearing a mask in indoor public spaces, holding all other variables constant. Similarly, a one-unit increase in perceived response efficacy is associated with an 8-percentage-point increase in mask-wearing, and a 10-percentage-point increase in perceived severity is associated with a 1-percentage-point increase in mask-wearing.

Critically, the sociodemographic predictors of mask-wearing in Model 1 (race and income) are no longer significant once EPPM variables are introduced (Model 2), providing preliminary support for the importance of psychological factors in predicting mask-wearing behavior. That said, various sociodemographic factors continue to be significantly correlated with mask-wearing. Respondents aged 55 and older are 8–12 percentage points more likely to wear masks (compared with respondents under 34), liberal respondents are 5–10 percentage points more likely to wear masks (compared with moderates), and mask-wearing increases with higher education levels.

Additionally, both models also include state fixed effects (Table 2). Compared with Colorado residents, probabilities of always wearing a mask are 16–19 percentage points lower in Iowa, 12–14 percentage points lower in Louisiana, 10–13 percentage points lower in Washington, and about 9–14 percentage points higher in both Massachusetts and Michigan. Gender and having children at home are not significantly associated with mask-wearing in either model.

To explore the EPPM hypothesis that engagement in risk-reduction behavior is most likely when threat- and efficacy-related

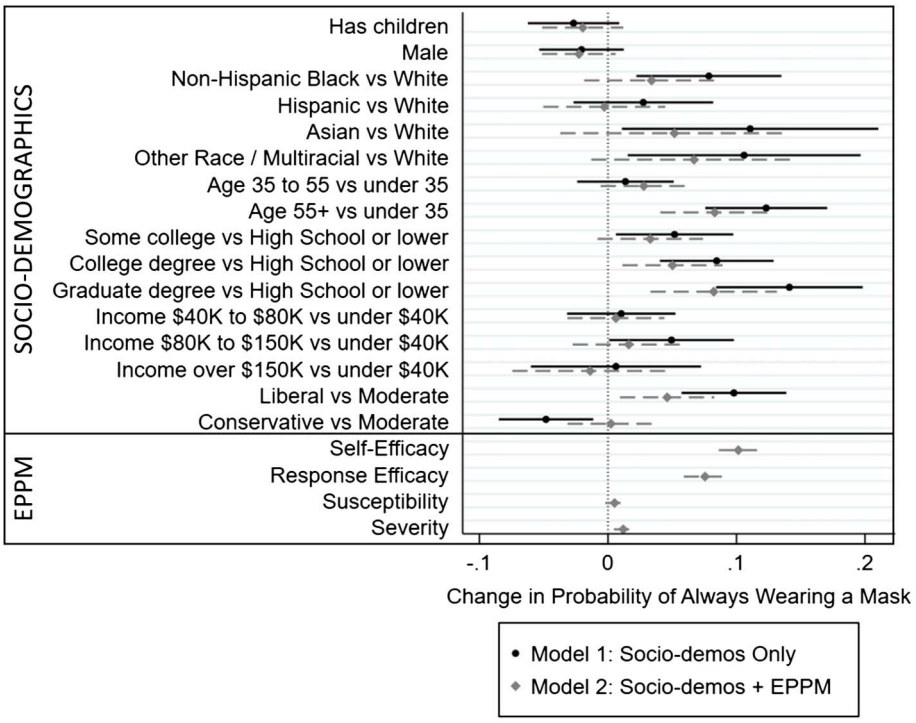

Fig. 1. Average marginal effects and 95% confidence intervals from ordinal logistic regression models. Plot shows predicted change in probability of always wearing a mask for a one-unit change in each variable, holding other variables at their means. Model 1 includes only sociodemographic variables. Model 2 includes EPPM variables related to threat and efficacy perceptions.

perceptions are both high, the authors tested the extent to which the three EPPM variables that were significant predictors in Model 2 (self-efficacy, response efficacy, and threat severity) interact to predict mask-wearing (Table 2, Model 3). This model specification—which includes sociodemographic and EPPM variables, as well as an interaction term between the two efficacy measures and a quadratic of the severity measure—was designed to capture a potential nonlinear relationship between perceptions of severity and frequency of mask wearing at different levels of perceived efficacy. Given that perceived susceptibility was not significant in Model 2, it was dropped from further analyses.

The interaction between the efficacy measures and the quadratic of perceived severity is statistically significant, as indicated in Table 2 (Model 3). This suggests that the combination of self-efficacy and response efficacy, as well as severity, is associated with the probability that an individual always wears a mask. It also highlights that the effect of perceived threat severity on mask-wearing differs across perceived efficacy levels. Fig. 2 illustrates this by plotting the predicted probability of always wearing a mask for four scenarios in which individuals perceive different levels of response and self-efficacy, across levels of perceived threat severity, holding all other variables constant. The four scenarios include (1) high self- and response efficacy, (2) high self-efficacy and low response efficacy, (3) low self-efficacy and high response efficacy, and (4) low self- and response efficacy. Self- and response efficacy were grouped together into scenarios in this figure because of the inclusion of a significant interaction effect of the two efficacy measures and threat severity, as well as for increased clarity in visualization.

As shown in Fig. 2, for respondents with high self- and response efficacy, the predicted probability of always wearing a mask in indoor public spaces is highest, above 80%, even at the lowest levels of perceived severity. For respondents with low self- and response efficacy, the predicted probability of always wearing a mask ranges from about 10% to 25% as perceived threat increases. In other words, individuals who perceive that they are not able to wear a mask, and that masks are not effective are unlikely to wear a mask, even if they perceive COVID-19 to be a serious threat.

A similar trend is seen for the two other groups who hold mixed perceptions of efficacy. Respondents with high self- but low response efficacy have a predicted probability of always wearing a mask that ranges from 50% to 75% as perceived threat increases. Respondents with low self- but high response efficacy show a similar trend: their predicted probability of always wearing a mask is lower, but it increases from about 30% to 35% as perceived threat severity increases. In sum, across the scenarios, the predicted probability of always wearing a mask indoors increases as perceived severity increases, although mask-wearing is always highest among those with high threat- and efficacy-related perceptions and always lowest among those with low threat and efficacy-related perceptions.

Discussion

Masks continue to be considered one of the most important public health interventions in the fight against COVID-19, even as a larger portion of the population becomes vaccinated. This study applies the EPPM to provide a more nuanced understanding of the relationship between psychological factors (i.e., perceived threat and efficacy) and mask-wearing. It is found that perceptions of self- and response efficacy are particularly important determinants of mask-wearing, even more so than many frequently cited sociodemographic factors (Brenan 2020; National Geographic 2020). These findings support the EPPM hypothesis that engagement in risk-reduction behavior is most likely when both threat- and efficacy-related perceptions are high, and least likely when both threat- and efficacy-related perceptions are low. They also add nuance to the current understanding of the relationship between different types of perceived efficacy

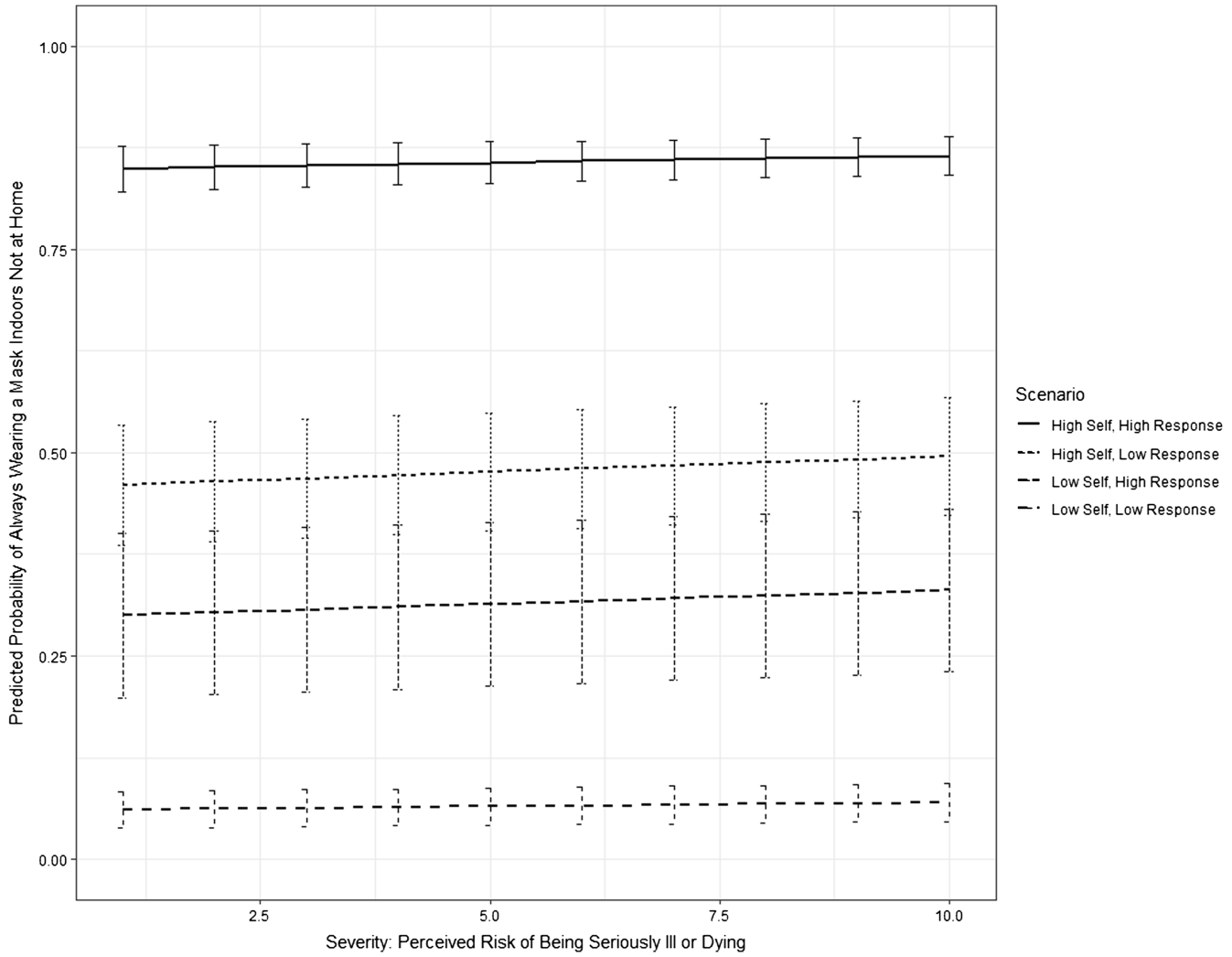

Fig. 2. Predicted probabilities and 95% confidence intervals of always wearing a mask for groups of respondents with different levels of perceived self- and response efficacy, at different levels of perceived threat severity, using data from Table 2 (Model 3) and holding all other variables constant.

and engagement in recommended risk-reduction behaviors, highlighting that self-efficacy is particularly important in the context of mask-wearing.

Given the cross-sectional nature of the data, one cannot determine the direction of causality of the findings (i.e., whether higher perceptions of efficacy *a priori* lead to a higher likelihood of always wearing a mask). It may be that people who wear masks for other reasons justify their behavior by adopting beliefs that masks are effective. However, if the causal relationships explicated in the EPPM hold, modified public messaging may be able to shape COVID-19 risk-reduction behaviors. Messages with efficacy-boosting components that underscore the relative ease and effectiveness of wearing a mask, for example, may better empower individuals to engage in the behavior, as opposed to messages using other strategies such as focusing on facts about the COVID-19 virus, generic explanations of risk-reduction behaviors, or underlying factors affecting individual susceptibility (Abrams and Greenhawt 2020; WHO 2020b).

For example, instead of highlighting the dangers COVID-19 poses for different age cohorts or individuals with certain preexisting conditions, a better strategy may be to emphasize that mask-wearing is a relatively simple, low-cost public health intervention that can provide enormous benefit to both individual and community health. Consistently communicating these recommendations can build trust in public officials and further reduce confusion about the necessity of continuing to engage in mask-wearing and other protective behaviors.

Additional research is also needed on the relative effectiveness of messaging strategies delivered by different messengers or framed in different ways (Crow and Jones 2018). For example, to what extent do individuals respond to messages when they are disseminated by a celebrity versus a US government official versus an independent scientist? Similarly, do individuals respond to messages framed as part of a larger story that leverages specific characters, settings, or plot arcs, or is a simple infographic or visual sufficient to influence behavior? To better answer these questions, the authors encourage public health officials to experiment with different efficacy-boosting messages contoured to different risk contexts and individuals, and to collect consistent longitudinal data to assess the impacts of these messages on mask-wearing and other behaviors.

Data Availability Statement

Some or all data, models, or code generated or used during the study are available in a repository or online in accordance with funder data retention policies. (https://osf.io/a9esw/).

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