The role of Perceived Risk, Stress, and Future Orientation on Mask Wearing During COVID-19

Diego Guevara Beltran¹, Calvin Isch², Jessica D. Ayers¹, Joe Alcock³, Jessica F. Brinkworth^{4,5},
Lee Cronk⁶, Hector Hurmuz-Sklias, Keith Tidball⁷, Andrew Van Horn⁶, Peter M. Todd² and
Athena Aktipis¹

¹Department of Psychology, Arizona State University

²Cognitive Science Program and Department of Psychological and Brain Sciences, Indiana
University Bloomington

³Department of Emergency Medicine, University of New Mexico

⁴Department of Anthropology, University of Illinois Urbana-Champaign

⁵Carl R. Woese Institute for Genomic Biology, University of Illinois Urbana-Champaign

⁶Department of Anthropology, Rutgers University - New Brunswick

⁷Department of Natural Resources, Cornell University

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Corresponding author. Diego Guevara Beltran, Department of Psychology, Arizona State University, Tempe, AZ 85287-1104, United States. Email: dquevar3@asu.edu.

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Abstract

Objective. Since the COVID-19 pandemic began, wearing protective facial masks has become a divisive issue. Yet little is known about what drives individual differences in mask wearing.

Methods and Measures. Here we surveyed an international cohort of participants ($N = 753$), about their use of masks and other variables related to mask wearing over three periods from July-August, 2020.

Results. We found that greater prevalence of COVID-19, higher perceived risk of infection, stress, and future orientation predicted more frequent use of masks. Future-oriented people also experienced greater stress and reported higher perceived risk of infection.

Conclusion. Results indicate that perceived risk of infection, stress, and future orientation reliably accounted for variation in reported mask-wearing behavior, but individual differences in mask-wearing intentions (e.g., protect self vs. others), and intergroup relations (e.g., political affiliation) should be considered in future investigations.

Keywords. COVID-19, face masks, perceived risk, stress, time orientation.

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Wearing surgical masks and cloth face coverings (hereafter “masks”) is associated with a reduction in infection risk (Chu et al., 2020) and transmission (Cheng et al., 2020; Liu & Zhang, 2020) of the SARS-CoV-2 virus, and they have been recommended by the U.S. Centers for Disease Control and Prevention, the WHO, and governments around the world (CDC, 2020; Greenhalgh et al., 2020) to reduce the spread of COVID-19. Masks can block the spread of 67-95% of virus-carrying droplets (Peeples, 2020). Not only is mask wearing effective, but it is also a relatively low cost and convenient measure to reduce the high costs of community transmission of the disease (Greenhalgh et al., 2020), making it a precaution worth taking (MacIntyre & Chughtai, 2020).

Despite recommendations to wear masks to reduce the spread of SARS-CoV-2, there remains a great deal of variation in compliance with mask-wearing. This variation made us interested in the question of why some individuals wear masks more often and in a broader array of contexts than others. Among the protective behaviors that help prevent the spread of SARS-CoV-2, mask wearing is readily observable, interpretable, and under the direct control of the individual (in contrast to social distancing, which requires cooperation with others). Mask wearing, like other protective behaviors, is likely influenced by many factors. In particular, mask wearing should be influenced by the prevalence of COVID-19 in one’s local community, which gives rise to perceptions of risk of infection, stress caused by the disease, and an individual’s present vs. future time orientation with regards to such risks. In this paper, we explore the effect of these factors on mask wearing during the early periods of the COVID-19 pandemic, as well as other individual factors previously found to influence protective behaviors.

Disease Avoidance and Time Orientation

Perceived risk of COVID-19 infection can motivate protective behaviors

During the COVID-19 pandemic, people attempted to protect themselves from disease

by engaging in protective behaviors such as mask wearing, hand washing, social distancing, and getting vaccinated. When people perceive their risk of contracting disease to be higher, they are more likely to engage in protective behaviors. A meta-analysis showed that people are more likely to get vaccinated against diseases like influenza if they think they are more likely to contract disease, if they think their disease-related symptoms will be more severe, and if they feel more susceptible to disease (Brewer et al., 2007). Conversely, when people felt that their susceptibility to infection is not under their control, and when no effective treatments were available, as in the previous SARS epidemic, their concern about contracting disease was elevated (Smith, 2006).

In the case of COVID-19, individuals who perceived their risk of COVID-19 to be higher engaged in more protective behaviors such as physical distancing and hand-washing (Yıldırım & Güler, 2020). In addition, those who believed protective behaviors were effective at preventing infection were more likely to engage in those behaviors, even if they had low perceived risk of infection (Jørgensen et al., 2020). Although disease-related risk is a multi-faceted construct that deals with perceived infectability, susceptibility, and severity of symptoms (Brewer et al., 2007), here we specifically focus on individuals' assessment of the risk of becoming infected. When people assess their risk of contracting disease to be high, this perceived risk can exacerbate feelings of stress (Li & Lyu, 2020).

Disease-related stress can motivate protective behaviors

People often experience heightened stress during disease outbreaks. For example, a survey of Hong Kong adults about their perceptions of the 2003 SARS outbreak showed that over a third of their sample reported heightened stress (Lau et al., 2005). Recent work from the current COVID-19 crisis also shows that people all over the world experienced pandemic-induced stress. A nationally representative survey of Chinese adults (N > 52,000) conducted in January, 2020 showed that 35% of respondents reported moderate distress (Qiu et al., 2020). Similarly, the prevalence of pandemic-induced stress has been reported among people in

Bangladesh (Islam et al., 2020), Iran, China, Japan, Nepal, India, Iraq, Spain, the UK, Nigeria, and Italy (Salari et al., 2020).

Moderate stress is sometimes beneficial, motivating people to reduce their exposure to threats and engage in protective behaviors (Brewer et al., 2007; Schneiderman et al., 2005). For example, stress can lead to reduced behavior, such as loss of appetite and low energy, which can reduce the likelihood of encountering threats (Eisenberger et al., 2017). Stress can also have opposing effects on social behavior depending on the target of interaction, motivating individuals to avoid threatening others, while at the same time seeking out support from close others (Eisenberger et al., 2017).

Stress brought about by the pandemic is likely attributable to multiple sources, including those related to disease concerns (Salari et al., 2020), financial concerns such as loss of employment (Béland et al., 2020), and social concerns such as feelings of isolation and loneliness (Ayers et al., 2021). It is therefore crucial for ongoing research to differentiate between (or control for) multiple sources of stress, as they may not uniformly contribute to protective behaviors.

Both perceived risk of COVID-19 infection and pandemic-related stress might be further influenced by time orientation. In particular, people with a greater future time orientation might consider both immediate as well as future risks more heavily compared to individuals with a more present time orientation, leading to higher assessments of infection risk and experiences of stress.

Individual Differences

Future orientation and protective behaviors

Future orientation is the extent to which individuals value the future compared to the present (Joireman et al., 2012). There is reason to think that future orientation should be associated with protective behaviors as engaging in protective behaviors requires a willingness to incur present costs to avoid exposure and potential infection. Some of these costs include

giving up close interactions with friends, and not attending events.

Greater concern for future consequences predicts protective health behaviors such as limiting exposure to sunlight (Heckman et al., 2009) and using condoms (Appleby et al., 2005). Concern about the future consequences of one's actions is also associated with health-oriented behavior (Joireman et al., 2012) such as healthy eating (Dassen et al., 2015).

People who consider the future consequences of their actions might be more attuned, or sensitive, to both current and future risks, such as the risk of becoming infected with COVID-19, which may, in turn, lead to experiencing greater pandemic-related stress. This sensitivity to risks and ensuing stress should motivate individuals to engage in protective behaviors such as mask wearing.

Demographics and protective behaviors during COVID-19

Pre-COVID-19 research has shown that demographic factors influence general compliance with protective behaviors, with older and more educated people engaging in more protective behaviors than younger and less educated people (Bish & Michie, 2010). Accordingly, more educated people reported greater pandemic-induced stress during the COVID-19 pandemic (Yıldırım & Güler, 2020). However, some recent work is not consistent with previous patterns. For example, younger people report more pandemic-related stress than older people (Qiu et al., 2020; Masters et al., 2020), a puzzling relationship, given that older people experience higher mortality from COVID-19 (Jordan et al., 2020). Researchers have speculated that this age difference in stress is in part due to younger people being exposed to more negative content about the pandemic on social media than their older counterparts (Qiu et al., 2020). Other work has highlighted the importance of other demographics: women are more likely to wear masks than men, though this was the case only in countries where mask wearing was not mandated (Capraro & Barcelo, 2020). Lastly, recent research on COVID-19 and political orientation show that, in the US, right-leaning people report lower intentions of engaging in protective behaviors (Kachanoff et al., 2020) and may also refuse to wear masks to signal

their political affiliation (Boykin et al., 2021).

The Present Work

The primary goal of this study was to test the associations between COVID-19 prevalence, perceived risk of COVID-19 infection, pandemic-related stress, and future time orientation on mask wearing, as these factors should be most strongly positively associated with the motivation to protect oneself from disease. In addition, we explore whether demographic and individual difference factors are associated with mask wearing, perceived infection risk and pandemic-related stress.

Method

We recruited an international sample of (primarily Western) participants through Prolific.co, a platform for online recruitment, for a larger study on COVID-19 and cooperation (citation removed for anonymity). Any person who was older than 18-years-old and was fluent in English was able to participate in the study. Participants took the study on fourteen different occasions from March 6th to August 22nd, 2020 approximately every two weeks. Here we report on three time points in which we collected the pertinent variables: July 11, 2020 ($N = 752$, $M_{age} = 29.11$, $SD_{age} = 10.60$, 51.0% male) July 25, 2020 ($N = 695$, $M_{age} = 29.70$, $SD_{age} = 10.80$, 52.6% male), and August 8, 2020 ($N = 634$, $M_{age} = 29.60$, $SD_{age} = 11.00$, 50.7% male). Participants came from 36 countries, including continental Europe ($N = 417$), North America ($N = 105$), the UK/Ireland ($N = 205$), and other countries ($N = 25$).

Due to participant fatigue considerations, and restrictions on survey length, we were not able to collect mask-wearing data on July 11, but we did collect data on perceived risk of infection and stress. We included these three time points to get a more accurate score of participants' perceived risk, and stress, as we expect that protective behaviors such as mask wearing should be influenced by both current and past assessments of infection risk/stress.

On July 25 and August 8, participants reported whether they had worn a mask and/or

socially distanced during the in-person interactions they had in the week prior to that time point (*During in-person interactions did you wear a mask and/or stay 6 feet (2 meters) away from the other person(s)?; 1 = Never, 3 = Half the time, 5 = Always*). Participants' responses to this item are hereafter referred to as 'mask wearing'. Participants also answered questions related to the larger study which are not part of the present paper. A list of all the questions that participants were asked can be found here (osf.io/k4wqg/?view_only).

To determine the local prevalence of COVID-19, we matched participants' postal codes to the COVID-19 Data Repository compiled by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (Dong et al., 2020). Using this database, we linked cumulative incidence rates (i.e., confirmed cases per 100,000 individuals), death rates (per 100,000 cases), and deaths per cases to the postal codes of 600 of our participants on July 11, 568 participants on July 25, and 520 participants on August 8, 2020. We were not able to match the prevalence of COVID-19 for participants who did not provide postal codes or who provided postal codes that were unidentifiable.

Across all three time points, participants reported their perceived risk of COVID-19 infection (*How likely do you think it is that you will become infected with COVID-19?; 1 = Not at all, 7 = Extremely*), and their COVID-19-related stress (*How stressed do you currently feel dealing with changes caused by COVID-19?; 1 = Not at all, 7 = Extremely*). On March 14, 2020, participants answered the Perceived Stress Scale, a 10-item validated and widely used scale of perceived stress (e.g., *In the last month, how often have you felt nervous and "stressed"?; 1 = never, 5 = very often*) (Cohen, 1988; Roberti et al., 2006). Demonstrating concurrent validity, our single measure of pandemic-related stress was positively correlated with the Perceived Stress Scale across the three waves of data collection reported in the present paper: July 11 ($r = 0.21, p < 0.001$), July 25 ($r = 0.21, p < 0.001$), and August 8 ($r = 0.36, p < 0.001$). Participant demographics included age, sex, education (1 = *Less than high school*, 8 = *Doctoral or professional degree*), subjective socioeconomic status (1 = *Much worse off than others*, 10 =

Much better off than others; (Adler et al., 2000), and political orientation (1 = *Extremely to the left*, 7 = *Extremely to the right*). Participants then completed the Consideration of Future Consequences Scale (Joireman et al., 2012; Strathman et al., 1994), a 14-item questionnaire with two subscales that separately measure two factors: concern for the immediate consequences (e.g., “*I only act to satisfy immediate concerns, figuring the future will take care of itself.*”; this sample’s Cronbach’s $\alpha = 0.80$), and concern for future consequences (e.g., “*I consider how things might be in the future, and try to influence those things with my day to day behavior.*”; this sample’s Cronbach’s $\alpha = 0.80$) of one’s behavior measured on a 7-point scale (1 = *Strongly disagree*, 7 = *Strongly agree*).

Finally, to control for alternative sources of stress caused by the current pandemic that may not stem from disease avoidance concerns, participants reported on three measures of financial concern which we developed for the purposes of the larger longitudinal project: *How likely do you think it is that you will lose your job because of the economic downturn associated with COVID-19* (1 = *Not at all likely*, 7 = *Extremely likely*, 8 = *Already have lost job*), *If you didn’t have a job, how long would your savings last?* (1 = *Already have used all of my savings*, 8 = *More than 6 months*), and *If you lost your job, how long do you think it would take to find another one?* (1 = *More than 6 months*; 8 = *Less than 1 month*). The Cronbach’s alpha of these financial concern items was low ($\alpha = 0.35$), so we treat them as individual items rather than a composite. We relied on correlation analyses, and linear regressions to answer our research questions. Analyses were conducted in SPSS V. 25. The analysis syntax as well as data used for analyses is made available through the Open Science Framework (osf.io/acjrh/?view_only=ad6ce5c56e0c44bfb50081d4788c22b). Study materials and procedures were approved by the Arizona State University’s Institutional Review Board (ID: STUDY00011678).

Results

What contributed to variation in mask wearing?

We were interested in whether the local prevalence of COVID-19, perceived risk of infection, stress, demographics, and time orientation explained variation in mask wearing. We report the zero-order correlations of these variables with mask wearing for both July 25 and August 8, 2020 in the Supplemental Analyses (Table S1; Figure S1). To test whether our predictor variables explained variation in mask wearing we computed an average composite of mask wearing from July 25 and August 8 ($\alpha = 0.73$). We then computed the average composite of perceived risk of infection ($\alpha = 0.92$), pandemic-related stress ($\alpha = 0.89$), and COVID-19 incidence rate ($\alpha = 0.99$) from July 11, July 25, and August 8. Given that COVID-19 incidence rate was highly positively skewed (Skewness = 4.02, SE = 0.9), we took the common logarithm of this variable. All covariates except participant sex were mean-centered and standardized. We found that COVID-19 incidence rate ($\beta = 0.18$, CI_{95%} [0.08, 0.28]), perceived risk of infection ($\beta = 0.16$, CI_{95%} [0.05, 0.28]), stress ($\beta = 0.17$, CI_{95%} [0.06, 0.28]), and consideration of future consequences ($\beta = 0.11$, CI_{95%} [0.002, 0.23]) were positively associated with mask wearing ($F(10, 388) = 7.20$, $p < 0.001$, $R^2 = 0.16$). No other predictors were associated with mask wearing (Table S2; Figure 1).

Figure 1*Predictors of mask-wearing behavior*

Note. Circles represent standardized beta estimates (β) and bars represent 95% confidence intervals. Statistically significant associations ($p < 0.05$) are shown in dark blue. CFC = Consideration of Future Consequences. An interactive version of Figure 1 can be found [here](#).

What contributed to variation in perceived risk of infection?

We ran a multiple linear regression with our composite measure of perceived risk of infection as the dependent variable, with the same predictors as in our previous model. All predictors were again mean-centered and standardized except for participant sex. We found that stress ($\beta = 0.52$, $CI_{95\%} [0.39, 0.65]$), education ($\beta = 0.18$, $CI_{95\%} [0.05, 0.32]$), and consideration of future consequences ($\beta = 0.17$, $CI_{95\%} [0.03, 0.32]$) positively predicted perceived risk of COVID-19 infection ($F(9, 397) = 11.98$, $p < 0.001$, $R^2 = 0.21$). No other predictors were associated with perceived risk of infection (Table S3; Figure 2).

Figure 2*Predictors of the perceived risk of COVID-19 infection*

Note. Circles represent standardized beta estimates (β) and bars represent 95% confidence intervals. Statistically significant associations ($p < 0.05$) are shown in dark blue. CFC = Consideration of Future Consequences. An interactive version of Figure 2 can be found [here](#).

What contributed to variation in pandemic-related stress?

We ran a multiple linear regression with our composite measure of stress as the dependent variable. Considering that participants may have experienced stress for concerns unrelated to COVID-19 infection, in addition to our set of predictor variables, we also included three items intended to measure financial concern: 1) how likely participants believed they are to lose their jobs due to COVID-19, 2) how long they believed it would take them to find a job if they lost their job, and 3) how long their savings would last if they did not have a job. Again, all predictors were mean-centered and standardized except for participant sex. We found that perceived risk of infection ($\beta = 0.52$, $CI_{95\%} [0.36, 0.67]$), consideration of future consequences ($\beta = 0.25$, $CI_{95\%} [0.09, 0.40]$), and indicating that your savings would last for less time ($\beta = 0.19$, $CI_{95\%} [0.04, 0.34]$) positively predicted stress ($F(12, 333) = 9.81$, $p < 0.001$, $R^2 = 0.26$). No other

predictors were associated with stress (Table S4; Figure 3).

Figure 3

Predictors of pandemic-induced stress

Note. Circles represent standardized beta estimates (β) and bars represent 95% confidence intervals. Statistically significant associations ($p < 0.05$) are shown in dark blue. CFC = Consideration of Future Consequences. An interactive version of Figure 3 can be found [here](#).

Discussion

We surveyed an international cohort of participants to understand variation in mask wearing paying special attention to perceived risk of infection, stress, and future time orientation as key candidate motivating variables. In the following sections, we discuss these predictors of mask wearing, as well as exploratory individual difference factors.

Predictors of mask wearing

Covid-19 prevalence, perceived risk of infection, and pandemic-related stress

In light of recent work regarding perceived risk of infection and stress during the COVID-19 pandemic (Jørgensen et al., 2020; Qiu et al., 2020; Salari et al., 2020; Yıldırım et al., 2020), we expected these two constructs to be key drivers of mask-wearing behavior. Accordingly, we found consistent positive correlations between these two measures with mask wearing across all three time points (r 's = 0.17-0.20; Table S1), and both perceived risk of infection ($\beta = 0.16$, $CI_{95\%} [0.05, 0.28]$), and stress ($\beta = 0.17$, $CI_{95\%} [0.06, 0.28]$) accounted for variation in mask wearing when controlling for other variables (Table S2). Notably, COVID-19 prevalence was also positively associated with mask wearing when controlling for other factors ($\beta = 0.18$, $CI_{95\%} [0.08, 0.28]$), indicating that other mechanisms beyond perceived risk of infection and stress account for variation in mask wearing. For example, some people may simply comply with mask-wearing mandates even if they might experience low levels of perceived risk and stress. Overall, our findings are consistent with other work showing that perceived risk of infection (Brewer et al., 2007), and moderate levels of stress (Eisenberger et al., 2017; Schneiderman et al., 2005) motivate protective behaviors more broadly.

Unlike our measure of perceived risk of COVID-19 infection, our measure of pandemic-related stress asked participants to report their level of stress due to the changes caused by the COVID-19 pandemic. As a result, participants could have experienced stress for reasons unrelated to disease concerns. Accordingly, we found that people who reported that their savings would last for a shorter period of time (if they had no job) reported greater stress ($\beta = 0.19$, $CI_{95\%} [0.04, 0.34]$; Table S4). However, it should be noted that the effect of perceived risk of infection on stress was nearly three times larger than the effect of having short-lasting savings, indicating that our measure of stress was indeed better captured by disease-related concerns than financial concerns.

Future orientation

We found that people with greater consideration for future consequences reported

wearing masks more often. While these associations were small, we observed consistent positive correlations across all three time points (r 's = 0.15-0.17; Table S1), and consideration of future consequences remained a positive predictor of mask wearing when controlling for other variables (β = 0.11, $CI_{95\%}$ [0.002, 0.23]; Table S2). People with a greater consideration for future consequences may weigh the potential risks of infection more heavily, in turn leading them to perceive a greater risk of contracting COVID-19, experience greater pandemic-related stress, and engage in preventative behaviors such as mask wearing more often as a result. In support of this view, we found that people with a greater consideration of future consequences were more likely to report higher perceived risk of infection (β = 0.17, $CI_{95\%}$ [0.03, 0.32]; Table S3), and stress (β = 0.25, $CI_{95\%}$ [0.09, 0.40]; Table S4). These findings are consistent with previous work showing that people with greater future orientation are more likely to engage in protective behaviors more broadly (Appleby et al., 2005; Flesia et al., 2020; Heckman et al., 2009; Joireman et al., 2012), and our results suggest that perceived risk of infection and stress may be key mechanisms via which future orientation promotes engagement in protective behaviors.

Individual differences

Age and sex

Even though the mortality rate of COVID-19 is much higher for older people (Jordan et al., 2020), we did not observe a correlation between age and mask wearing (Table S1). One possible explanation for this lack of association is that the majority of our participants were younger than 51-years-old, preventing us from observing what might be a stronger positive association between mask wearing and older age. Alternatively, older people may have simply engaged in fewer activities that required them to wear masks. Compared to younger people, older people are less likely to engage in leisure physical activities (Crombie et al., 2004; Leslie et al., 2001). During the early months of the pandemic older people also reported making fewer friends and being less motivated to make new friends (Ayers et al., 2021). In addition, in some European countries, older people were more strongly encouraged by the government to practice

social distancing (Rohr et al., 2020).

Somewhat inconsistent with previous research, we found that women did not report greater use of masks than men. This difference could emerge from the fact that previous work regarding sex differences and mask wearing asked about intentions, while here we asked about reported use of masks (Capraro & Barcelo, 2020). In addition, previous work finds that men only reported lower intentions to wear masks if they resided in countries where mask wearing mandates were not enforced, which we did not measure in the present study.

Political orientation

Unlike previous work (Kachanoff et al., 2020), we did not find that people politically inclined to the right were less likely to report wearing masks. One possible reason is that, in contrast to previous studies that relied solely on US participants, our participants resided primarily in European countries. Mask wearing may be more politicized in the US than in other countries. It is also possible that political orientation may have a different effect on mask wearing depending on the social context. For example, it may be that people politically inclined to the right are less likely to wear masks than people politically inclined to the left only when their reputation or identity is at stake. In the US, for example, people inclined politically to the right do not wear masks in order to signal their political affiliation (Boykin et al., 2021). In addition, we may have failed to observe a relationship between political orientation and mask wearing in our sample simply because of the types of activities people engaged in. Some activities (e.g., while working, shopping indoors) enforce mask-wearing mandates, while other types of activities do not (e.g., attending a party, exercising outdoors).

Predictors of perceived risk of infection and stress

COVID-19 prevalence

Predictably, participants from communities with a greater prevalence of COVID-19 reported higher levels of stress and perceived risk of infection across all three time points (ρ 's = 0.11-0.20; Table S1). However, when controlling for other variables, prevalence of COVID-19

was not directly associated with either perceived risk of infection ($\beta = 0.07$, $CI_{95\%} [-0.06, 0.20]$; Table S3), or stress ($\beta = 0.10$, $CI_{95\%} [-0.04, 0.67]$; Table S4). In addition to reporting greater future orientation, participants who experienced higher stress were more likely to experience greater perceived risk of infection ($\beta = 0.52$, $CI_{95\%} [0.39, 0.65]$; Table S3); and participants who reported higher perceived risk of infection reported higher stress ($\beta = 0.52$, $CI_{95\%} [0.36, 0.67]$; Table S4). These results suggest that while COVID-19 prevalence is associated with both perceived risk and stress, there may be bidirectional effects between perceived risk of infection and pandemic-related stress that account for the variance between protective behaviors and disease prevalence. Future work could investigate whether, in the face of increasing disease prevalence, perceived risk of infection leads to higher disease-related stress or if disease-related stress precedes perceived risk of infection.

Individual differences

As with mask wearing, we found no association between age and perceived risk of infection or stress. One possible explanation for this finding is that, compared to younger people, older people may have been less likely to engage in activities that increased their risk of contracting COVID-19. Generally, older people are less likely to engage in leisure physical activity than younger people (Crombie et al., 2004; Leslie et al., 2001). In addition, older people in some European countries were more strongly encouraged by their governments to engage in social distancing (Röhr et al., 2020). Older people also reported making fewer friends and being less motivated to make new friends than younger people during the first months of the pandemic (Ayers et al., 2021). At the same time, however, this lack of association between our measures and age may stem from the fact that our sample is mostly composed of people who are under 51-years-old.

With regards to participant sex, we found that across all three time points women reported greater perceived risk of infection and stress than men (r 's = 0.10-0.17). These associations are in line with previous work showing that women are generally more risk averse

than men (Byrnes et al., 1999; Sapienza et al., 2009); but see Flesia et al., 2020 for a discussion on the magnitude of this sex difference), and report greater perceived risk and stress than men during the pandemic (Qiu et al., 2020; Yıldırım & Güler, 2020). However, when pitted against other variables, participant sex was no longer associated with perceived risk of infection ($\beta = 0.12$, $CI_{95\%} [-0.14, 0.38]$; Table S3), or stress ($\beta = 0.23$, $CI_{95\%} [-0.06, 0.52]$; Table S4), indicating that participant sex itself does not account for variation in perceived risk of infection when accounting for stress, nor for variation in stress when accounting for perceived risk of infection.

Participants with greater educational attainment reported higher perceived risk of infection (r 's = 0.11-0.15), but not significantly different levels of stress compared to people with lower educational attainment. Although educational attainment was not associated with mask wearing (Table S1-S2), educational attainment explained variation in perceived risk of infection even when controlling for other factors ($\beta = 0.18$, $CI_{95\%} [0.05, 0.32]$; Table S3), which is consistent with previous work showing that people with higher educational attainment are better at searching for and understanding COVID-19-related information (Okan et al., 2020). Despite reporting higher perceived risk of infection and a better understanding of COVID-19, people with greater educational attainment do not appear to differ in their reported use of masks than people with lower educational attainment.

Finally, we found that politically right-leaning people reported lower perceived risk of infection and stress (but only on August 8, r 's = -0.08 to -0.11; Table S1), but these associations were weak. In combination with previous studies, our results suggest that to the extent that right-leaning individuals are less willing to engage in protective behaviors against COVID-19, this unwillingness may be less influenced by disease-related concerns than by concerns regarding their political beliefs and group membership (Boykin et al., 2021; Kachanoff et al., 2020). Future experimental work could simultaneously manipulate disease concern and political affiliation saliency to test the relative contribution of these two motivators on mask wearing and

other protective behaviors.

Limitations

Measurement limitations

An important limitation that should be addressed involves the operationalization of our measures. First, our measure of COVID-19 prevalence corresponded to the dates on which data were collected (i.e., July 11, July 25, and August 8, 2020). This is a limitation because people's perceived risk of COVID-19 and stress are likely a result of past and repeated exposure to information about disease prevalence, not just the incidence rate on the day of data collection. Future work should address the temporal component of disease prevalence, the various components of infection risk, and their impact on mask wearing.

Demographics and generalizability

There are likely environmental and social factors that contribute to variation in mask wearing that we did not consider here. Changes in norms and mask-wearing mandates in people's local communities have been shown to increase adherence to mask-wearing recommendations (Betsch et al., 2020). Our current analyses do not allow us to disentangle how demographic and psychological factors contribute to mask wearing after accounting for local variation in mandates.

Further, a majority of our participants (96%) were younger than 51-years-old, constraining the usefulness of the observed associations (or lack thereof) between our variables of interest and age. Finally, while our sample is composed of an international cohort, most of our participants came from Europe (83.3%), and participants did not reflect nationally representative groups for each respective country. Thus, our findings may not generalize to larger, nationally representative populations.

Future Directions

Although we observed reliable associations between stress, perceived risk of infection,

and mask wearing, it is unclear how the prevalence of COVID-19 increases perceived risk of infection and stress, and, in turn, causally influences adherence to mask wearing. Longitudinal analyses testing the pathways between these variables could reveal the extent to which the local prevalence of COVID-19 influence mask wearing as mediated by changes in the perceived risk of infection and/or stress over time. In future work, experimental manipulations could also make it possible to draw causal inferences among some of these variables. Future work could ask participants to make decisions about mask wearing in the case of a future respiratory disease pandemic with different fictional scenarios varying in factors such as incidence rate, risk of infection, and severity of the symptoms. By manipulating the perceived incidence of disease, it would be possible to see how these factors affect perceived risk of infection, stress, and protective behaviors such as mask wearing.

The role of symbolic meaning and groups

When it comes to understanding why some groups of people do not wear masks, one potential explanation is that mask wearing can have different meanings to different people. As Witte (Witte et al., 2020) wrote “at the heart of the dismal U.S. coronavirus response” is a “fraught relationship with masks.” Anthropologist Graham Jones noted that masks are “one of the most important human artifacts” and that

cloth masks have come to figure into everyday interaction rituals in ways that reflect central functions that anthropologists have long associated with masking: subsuming individual identities within culturally constructed personae and differentiating groups of people based on power and privilege.

Given the many interpretations people that can arise, it would be valuable to explore whether people form attributes of group membership, likeability, or intelligence based on mask wearing.

Conclusion

Our primary goal in conducting this research was to understand variation in adherence to mask wearing and the factors associated with this protective behavior. People wore masks

more often if they resided in places with higher COVID-19 prevalence, if they reported higher perceived risk of infection and stress, and when they were more future oriented. Despite the continued transmission of COVID-19, many remained reluctant and/or indifferent to mask wearing. Understanding the environmental and psychological sources of mask-wearing behavior may help in the design of interventions to limit the spread of present or future airborne diseases.

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Online Supplement

**The role of Perceived Risk, Stress, and Future Orientation
on Mask Wearing During COVID-19**

Supplemental Analyses

Supplemental Tables S1-S4

Supplemental Figures S1-S3

Supplemental Analyses

We tested for correlations between mask wearing on July 25, and August 8, 2020, with the prevalence of COVID-19, perceived risk of infection, stress, time orientation, and demographics (Table S1 and Figure S1), as well as correlations between perceived risk of infection and pandemic-related stress with these same set of variables (Table S1 and Figures S2-S3). To correct for the number of exploratory comparisons we ran, we adjusted significance using the false discovery rate (FDR) procedure (Benjamini & Hochberg, 1995). For the application of FDR, correlation analyses were separated by outcome variable (i.e., mask wearing, perceived risk of infection, and stress), but not time point, with false discovery rate set to 5%. This approach allowed us to minimize the possibility of finding false positives while maintaining reasonable analytical power.

Table S1*Correlates of mask wearing, perceived risk of infection, and stress*

	July 11 (N = 439)		July 25 (N = 429)			August 8 (N = 406)		
	COVID-19 perceived Risk	COVID-19 Stress	Mask/ distance	COVID-19 perceived Risk	COVID-19 Stress	Mask/ distance	COVID-19 perceived Risk	COVID-19 Stress
COVID-19 perceived risk	-	-	0.19**[†]	-	-	0.17**[†]	-	-
COVID-19 stress	0.29**[†]	-	0.20**[†]	0.36**[†]	-	0.18**[†]	0.26**[†]	-
COVID-19 incidence rate	0.11*^ρ	0.20**^ρ	0.21**^ρ	0.14**^ρ	0.16**^ρ	0.16**^ρ	0.10*^ρ	0.09 ^ρ
COVID-19 death rate	0.15**^ρ	0.17**^ρ	0.22**^ρ	0.16**^ρ	0.17**^ρ	0.18**^ρ	0.13*^ρ	0.12*^ρ
COVID-19 deaths/cases	0.15**^ρ	0.13**^ρ	0.14**^ρ	0.11*^ρ	0.13*^ρ	0.14**^ρ	0.11*^ρ	0.12*^ρ
Age	0.004	-0.05	0.04	0.01	-0.07	0.09	0.005	-0.01
Sex (women)	0.17**[†]	0.11**[†]	0.08 [†]	0.12*[†]	0.10*	0.09 [†]	0.12*[†]	0.16**[†]
Education	0.15**[†]	0.06 [†]	0.03 [†]	0.14 [†]	0.02 [†]	0.03 [†]	0.11**[†]	0.05 [†]
Subjective SES	0.02 [†]	-0.02 [†]	-0.05 [†]	0.002 [†]	-0.04 [†]	0.006 [†]	0.02 [†]	-0.03 [†]
Political orientation (right leaning)	-0.06 [†]	-0.05 [†]	-0.05 [†]	-0.06 [†]	-0.06 [†]	-0.05 [†]	-0.08*[†]	-0.11*[†]
CFC-future consequences	0.17**	0.18**	0.17**	0.22**	0.22**	0.15**	0.13**	0.24**
CFC-immediate consequences	-0.03	-0.04	-0.10*	-0.03	-0.06	-0.09	-0.07	-0.13*

Note. * = $p < 0.05$, ** = $p < 0.01$, ρ indicates Spearman's Rho, and τ indicates Kendall's Tau-b, correlations. All others show Pearson's r . Sample sizes reflect correlations with listwise deletion for each respective timepoint. Correlations in bold are robust to False Discovery Rate adjustments applying the Benjamini-Hochberg procedure.

Supplemental Tables

Table S2

Multiple linear regression predicting mask wearing (July 25 and August 8 composite)

	β	SE	t	p	95% CI	
Intercept	3.47	0.16	20.97	< 0.001	3.14	3.79
COVID-19 incidence	0.18	0.05	3.46	0.001	0.08	0.28
Perceived risk	0.16	0.06	2.84	0.005	0.05	0.28
Stress	0.17	0.06	3.02	0.003	0.06	0.28
Age	0.04	0.05	0.91	0.36	-0.05	0.14
Sex (women)	0.10	0.10	0.97	0.33	-0.10	0.31
Education	0.03	0.05	0.49	0.62	-0.08	0.14
Subjective SES	-0.05	0.06	-0.97	0.33	-0.16	0.06
Political Orientation (right)	-0.001	0.05	-0.02	0.98	-0.10	0.10
CFC-Future	0.11	0.056	1.99	0.047	0.002	0.23
CFC-Immediate	-0.03	0.06	-0.48	0.63	-0.14	0.08

Note. For our measure of mask wearing, participants were asked: *During these in-person interactions did you wear a mask and/or stay 6 feet (2 meters) away from the other person(s)?* (1 = *Never*, 3 = *Half the time*, 5 = *Always*). CFC = consideration of future consequences, statistically significant associations are shown in bold.

Table S3*Multiple linear regression predicting perceived risk (July 11, July 25 and August 8 composite)*

	β	SE	<i>t</i>	<i>p</i>	95% CI	
Intercept	3.48	0.21	16.48	< 0.001	3.06	3.89
COVID-19 incidence	0.07	0.06	1.12	0.27	-0.06	0.20
Stress	0.52	0.07	7.73	< 0.001	0.39	0.65
Age	0.03	0.06	0.52	0.59	-0.09	0.15
Sex (women)	0.12	0.13	0.92	0.35	-0.14	0.38
Education	0.18	0.07	2.63	0.01	0.05	0.32
Subjective SES	0.04	0.07	0.59	0.55	-0.10	0.18
Political orientation (right)	-0.09	0.07	-1.31	0.19	-0.22	0.04
CFC-Future	0.17	0.07	2.43	0.01	0.03	0.32
CFC-Immediate	0.05	0.07	0.66	0.51	-0.09	0.19

Note. For our measure of perceived risk of infection, participants were asked: *How likely do you think it is that you will become infected with COVID-19? (1 = Not at all, 7 = Extremely).* CFC = consideration of future consequences, statistically significant associations are shown in bold.

Table S4*Multiple linear regression predicting stress (July 11, July 25 and August 8 composite)*

	β	SE	<i>t</i>	<i>p</i>	95% CI	
Intercept	3.57	0.23	15.51	< 0.001	3.11	4.02
COVID-19 incidence	0.10	0.07	1.34	0.18	-0.04	0.24
Perceived risk	0.52	0.08	6.74	< 0.001	0.36	0.67
Age	-0.09	0.07	-1.42	0.15	-0.22	0.03
Sex (women)	0.23	0.15	1.56	0.12	-0.06	0.52
Education	-0.02	0.08	-0.25	0.80	-0.17	0.13
Subjective SES	-0.03	0.08	-0.42	0.68	-0.19	0.13
Political orientation (right)	-0.03	0.07	-0.46	0.64	-0.18	0.11
CFC-Future	0.25	0.08	3.03	0.003	0.09	0.40
CFC-Immediate	-0.02	0.08	-0.30	0.76	-0.18	0.13
How likely are you to lose your job due to COVID?	0.14	0.08	1.80	0.07	-0.01	0.30
If you lost your job, how long until you find another one?	0.11	0.08	1.39	0.16	-0.046	0.27
If you didn't have a job, how long would your savings last?	0.19	0.07	2.53	0.01	0.042	0.34

Note. For our measure of stress, participants were asked: *How stressed do you currently feel dealing with changes caused by COVID-19?* (1 = *Not at all*, 7 = *Extremely*). CFC = consideration of future consequences, statistically significant associations are shown in bold.

Supplemental Figures

Figure S1

Correlates of mask-wearing behavior

Note. The left column shows data from July 25, and the right column shows data from August 8, 2020. An interactive version of Figure S1 can be found [here](#).

Figure S2

Correlates of perceived risk of COVID-19 infection

Note. The left column shows data from July 11, the middle column shows data from July 25, and the right column data from August 8, 2020. An interactive online version of Figure S2 can be found [here](#).

Figure S3

Correlates of COVID-19-related stress

Note. The left column shows data from July 11, the middle column shows data from July 25, and the right column data from August 8, 2020. An interactive online version of Figure S3 can be found [here](#).