Intentions to comply with COVID-19 preventive behaviors are associated with personal beliefs, independent of perceived social norms

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Abstract

Social norms can be an effective way to promote public health and encourage healthy behaviors among individuals. The global COVID-19 pandemic has prompted health officials to call for new behavioral norms to help prevent the disease's spread, for example "social distancing" measures. Yet whether people actually intend to engage in these behaviors (behavioral intention) may depend on both whether they personally find them effective (individual beliefs), and whether they think others will engage in them too (perceived norms). In this study we tested three hypotheses on the relationships between individual beliefs, perceived norms, and behavioral intentions related to COVID-19 preventive health behaviors. We predicted: H1) that perceptions of others' beliefs about the importance and impact of preventive behaviors (perceived norms) would be lower than individuals' own beliefs (i.e., a pluralistic ignorance effect); H2) that perceived norms and individual beliefs would each predict behavioral intentions; and H3) that the difference between perceived norms and individual beliefs would uniquely predict behavioral intentions. We observed large self-other differences in beliefs about preventive health behaviors (support for H1). However, only individuals' own beliefs were associated with behavioral intention, not perceived norms or the self-other gap (no support for H2 or H3). In short, individuals did not differ in their preventive behavioral intentions based on the differences (or their lack thereof) between perceived social norms and their personal beliefs. Participants who strongly believed that preventive behaviors are important ignored normative pressures from average Americans, who they perceived as less concerned than themselves. Together, these findings highlight the different roles personal beliefs and perceived norms might play in forming behavioral intentions.

Introduction

Social norms strongly affect behavior (Cialdini & Goldstein, 2004), but people's perceptions of norms do not always reflect reality. Misperceiving social norms can shift attitudes in direction of the misperceived norm and inhibit corrective behavior (Bursztyn et al., 2018; Levendusky & Malhotra, 2016; Prentice & Miller, 1993), including in contexts of sudden norm changes such as public health crises (Monin & Norton, 2003). The COVID-19 outbreak, a global pandemic caused by the novel coronavirus SARS-CoV-2, has prompted health officials to call for new behavioral norms to reduce the disease's spread, such as "social distancing" (Glass et al., 2006). Dynamic, collective norms have been shown to compel individuals to change their behaviors (Sparkman & Walton, 2019), highlighting the potential for social norms to help facilitate compliance with COVID-19 preventive behaviors (Van Bavel et al., 2020). Still, research to date has been sparse with respect to the social norms individuals actually perceive, how those perceptions differ from their own beliefs, and how these perceptions are associated with behavioral intentions. To better understand how policymakers might persuade members of the public to adhere to behavioral recommendations, it is necessary to examine these perceived norms and their impact on behavioral intentions.

The present study tests three hypotheses related to the relationship between individual beliefs, perceived norms, and behavioral intentions surrounding a series of COVID-19 preventive behaviors. To test these hypotheses, we used a cross-sectional, repeated-measures survey where US participants provided their perceptions of the importance and impact of five preventive behaviors (staying home, avoiding friends, avoiding physical contact, self-quarantining if sick, and regular hand washing) for themselves and for others, along with their intentions to engage in each of these behaviors.

Hypothesis 1a predicted that individuals' perceptions of the average Americans' beliefs (i.e., perceived norms) about the importance and impact of preventive behaviors would be significantly lower than their own personally held beliefs on the matter. Hypothesis 1b and 1c were secondary hypotheses: Hypothesis 1b predicted that this pluralistic ignorance effect would be moderated by political orientation and psychological reactance, and hypothesis 1c predicted that this effect would be moderated by the specific behaviors at issue. Evidence for hypothesis 1 would suggest that individuals are underestimating the strength of social norms related to preventive health behaviors among their fellow Americans.

Hypothesis 2 predicted that individual beliefs and perceived norms would both independently predict behavioral intentions, and hypothesis 3 predicted that the difference between individual beliefs and perceived norms would uniquely predict behavioral intentions. Evidence for hypotheses 2 and 3 would suggest that a tendency to underestimate social norms affects individuals' intentions to engage in preventive health behaviors.

The results of the present study provide evidence in favor of hypothesis 1, but do not provide evidence for hypotheses 2 and 3. In support of hypothesis 1, participants' perceptions of social norms related to preventive behaviors were significantly lower than their own personally held beliefs about the importance and impact of such behavior. Yet we found that in spite of that difference between perceived norms and participant's personal beliefs, only their beliefs significantly predicted behavioral intentions, which were on average high.

Open Science

All study stimuli, data and analyses presented below, and materials necessary for replication can be found on the Open Science Framework (<https://osf.io/hqd39/>). This study's design, primary hypotheses and analyses were preregistered (<https://osf.io/236cy>). If a planned analysis deviates from the preregistration it is noted explicitly and explained in the method section. Analyses that were not preregistered are also explicitly stated as such. Sample size was determined *a priori* (see method section). Open materials were prepared primarily by the lead author; please do not hesitate to contact them if you have questions.

Method

Participants

Participants were 302 United States residents recruited through the online survey recruitment platform Prolific, where participants must have had a 95% approval rate in past studies to participate. The study was advertised as taking 5 minutes ($Median_{Duration} = 5$ minutes 16 seconds) to complete, and paid \$1 upon completion. The study involved no deception or incomplete disclosure. Participants who failed an attention check ($n = 23$) and who completed the survey in less than 90 seconds ($n = 0$) were excluded from all analyses, per the preregistration, resulting in a final $N = 279$ (53% female, $M_{Age} = 31.21$, $SD_{Age} = 10.45$). The preregistered target sample size was $N = 300$ with the expectation of a ~15% exclusion rate and final $N = 255$, which is powered at 90% to detect a small effect size for the planned analysis of hypothesis 3 (see the preregistration for details: <https://osf.io/236cy>). All participants completed the survey on April 8th, 2020.

Materials & Procedure

Participants completed an online questionnaire using the Qualtrics survey platform (survey language can be found on the OSF: <https://osf.io/hqd39/>). After providing informed consent and reading basic instructions describing the study's purpose and structure, participants answered a series of questions about five COVID-19 preventive health behaviors: "Leaving your home only for essentials," "avoiding face-to-face interactions with friends," "engaging in physical contact with no one other than those you live with," "self-quarantining if feeling sick for a minimum of 14 days," and "regular hand-washing for 20 seconds."

First, participants were asked about the "importance" of these behaviors, where importance was defined to participants as "the behavior is something one should do." On 0-100 slider scales participants were asked how important (0 = "Not at all important," 100 = "Extremely important") they personally believe these behaviors are for preventing the spread of COVID-19, and how important they believe the average American thinks the behaviors are. The order of the self and other blocks were counterbalanced, and the order of behavioral items within each block were randomized. Next, participants were asked about the perceived "impact" of these behaviors (0 = "Not at all impactful," 100 = "Extremely impactful"), where impact was defined to participants as "the behavior will make a difference." As with the importance measure, the impact items were asked at the self and other levels, with that order counterbalanced and behavior items within block randomized. After the importance and impact measure, participants were asked how likely they are to engage in each of the five preventive behaviors (0 =

“Extremely unlikely, 100 = “Extremely likely”), with the order of the five behavior items randomized.

Afterwards, participants responded to an attention check. Failure on the attention check did not affect payment or ability to continue the survey. Rather, pass/failure was merely recorded and used to exclude participants from all analyses after data collection completed. The attention check read “Please, in the box below, write out the answer to the following math problem, capitalizing the first letter of your answer (e.g. “Eight”, not “eight” or “8”). What does one plus three equal?” Any response other than “Four” was considered a failure.

Participants then responded to several questions related to how COVID-19 has affected them (e.g., whether they have been exposed), and their overall perceptions of the pandemic. The order of all these questions was randomized. Participants then rated their agreement on 7-point Likert scales (1 = “Strongly disagree, 7 = “Strongly agree”), with three items measuring reactance/beliefs about freedom ($M = 5.91$, $SD = 1.02$, $\alpha = 0.82$, $\omega = 0.84$): “I care about my freedom to choose,” “I care about making decisions on my own,” and “I dislike being pressured into decisions.” Lastly, participants responded to basic demographic questions and a measure of Left-Right political orientation on a 0-10 scale ($M = 3.34$, $SD = 2.59$); then the study ended.

Results

All primary analyses were conducted using linear mixed-effects modeling via the lme4 package v. 1.1-23 (Bates et al., 2015) in R v. 3.6.2. All models utilized REML estimation, and degrees of freedom and p -values were computed using Satterthwaite’s approximation.

Descriptive Findings

Tables 1 and 2 below provide the means and standard deviations for the belief, perceived norms, and behavioral intention items. In Table 1, “Response” refers to whether the item was individuals’ own beliefs or perceptions of the average American’s beliefs (perceived norms), and “Measure” refers to whether the item was measuring perceived importance or impact.

Participants also indicated the ways in which the pandemic has directly affected their lives. Participants were asked whether they had been exposed to or contracted COVID-19 (5.38% “Yes”, 93.19% “No”, 1.43% “Prefer not to answer”), whether they have suffered a direct financial loss (49.10% “Yes”, 49.46% “No”, 1.43% “Prefer not to answer”), whether they are subject to a government stay-at-home order (89.25% “Yes”, 8.60% “No”, 2.15% “I do not know”), whether they have moved/relocated (7.89% “Yes”, 91.40% “No”, 0.72% “Prefer not to answer”), their perceived level of financial stability relative to before the pandemic (1-7 Likert where 1 = Less stability, 4 = No change, 7 = More; $M = 3.07$, $SD = 1.16$), their trust in State & local health officials (1-7 Likert where 1 = Very low, 7 = Very high; $M = 4.64$, $SD = 1.54$) and elected officials ($M = 4.22$, $SD = 1.53$) to handle the pandemic, and their relative perceptions of how at-risk they personally are for contracting COVID-19 (1-7 Likert where 1 = Very low, 4 = Average, 7 = Very high; $M = 4.55$, $SD = 1.20$).

Table 1: Beliefs and Perceived Norms Means

Response	Behavior	Measure	Mean	SD
Belief	Contact	Impact	90.30	15.60
Belief	Contact	Importance	90.22	16.94

Belief	Friends	Impact	88.20	17.34
Belief	Friends	Importance	86.95	17.93
Belief	Hand_Washing	Impact	91.96	14.34
Belief	Hand_Washing	Importance	93.69	12.59
Belief	Leaving_Home	Impact	89.53	15.88
Belief	Leaving_Home	Importance	89.54	16.07
Belief	Quarantine	Impact	95.88	10.11
Belief	Quarantine	Importance	96.97	9.16
Norms	Contact	Impact	66.82	22.13
Norms	Contact	Importance	67.20	24.20
Norms	Friends	Impact	62.08	23.45
Norms	Friends	Importance	63.23	24.91
Norms	Hand_Washing	Impact	74.44	22.89
Norms	Hand_Washing	Importance	75.43	23.97
Norms	Leaving_Home	Impact	64.00	24.00
Norms	Leaving_Home	Importance	65.03	24.70
Norms	Quarantine	Impact	78.93	21.33
Norms	Quarantine	Importance	77.78	23.38

Table 2: Behavioral Intentions Means

Response	Behavior	Mean	SD
Intentions	Contact	86.62	25.56
Intentions	Friends	89.17	20.93
Intentions	Hand_Washing	91.15	18.32
Intentions	Leaving_Home	89.18	19.29
Intentions	Quarantine	93.60	19.54

Preregistered Hypothesis 1a

Hypothesis 1a was confirmatory and predicted a pluralistic ignorance effect where perceived social norms related to the importance and impact of preventive behaviors, measured as perceptions of the “average American’s” beliefs, would be significantly lower than individuals’ own beliefs about those preventive behaviors. To test hypothesis 1a, we utilized linear mixed effects modeling where perceived norms were modeled as the dependent variable, individual beliefs as the independent variable, and participants were modeled as random intercepts to account for repeated measures across the five preventive behavior items and two importance/impact items. Variables were centered such that the intercept would reflect the mean difference between perceived norms and individual beliefs¹.

Our analysis found strong support for hypothesis 1a. Table 3 below displays the results of the linear mixed effects model, and Figure 1 displays the data and regression line. On average, perceived norms were 21.84 points lower (on a 100 point scale, $M_{\text{Belief}} = 91.33$, $M_{\text{Norm}} =$

¹ Note minor deviation from the preregistration: We erred in saying that centering all the variables at the scale midpoint of 50 would lead the model’s intercept to reflect the difference of the IV and DV, therefore serving as a test hypothesis 1a. Centering both variables on the IV is in fact the method for the intercept to reflect a mean difference (Fletcher & Kerr, 2010; West & Kenny, 2011). We regret this error, and used this proper centering method when testing hypotheses 1a-c and 2.

69.49) than individuals' own beliefs about the importance and impact of five preventive health behaviors. We found a positive linear relationship between individuals' own beliefs and perceived norms ($b = 0.49$).

Table 3: Testing Hypothesis 1a

<i>Predictors</i>	Perceived Norms		
	<i>b</i>	<i>CI</i>	<i>p</i>
(Intercept)	-21.833	-23.916 – -19.749	<0.001
Beliefs	0.488	0.434 – 0.543	<0.001
Random Effects			
σ^2	278.21		
$\tau_{00 \text{ ID}}$	287.50		
ICC	0.51		
N_{ID}	279		
Observations	2790		
Marginal R^2 / Conditional R^2	0.088 / 0.552		

Figure 1: Beliefs and Norms Relationships

Figure 1: Displayed are the data and linear regression line, with 95% confidence intervals, for the analysis that tested hypothesis 1a (see Table 3 for detailed statistics). We found a positive linear relationship between beliefs and perceived norms.

Preregistered Hypothesis 1b

Hypothesis 1b was exploratory and predicted that the pluralistic ignorance effects from hypothesis 1a would be moderated by both political orientation and psychological reactance. To test hypothesis 1b we extended the model used to test hypothesis 1a by building two additional models, where political orientation and psychological reactance (both mean-centered) were entered respectively as interactive moderators with individuals' beliefs in predicting perceived norms. We then used post-hoc tests to examine whether the intercept estimates (our measure of mean differences) at ± 1 SD of the moderators significantly differed from the intercept estimate at the moderators' mean.

We found no support for hypothesis 1b. We found no significant interaction of political orientation and individual beliefs in predicting perceived norms ($b = 0.00$, 95% CI = $[-0.02, 0.02]$, $p = 0.902$), nor was political orientation itself associated with perceived norms ($b = 0.28$, 95% CI = $[-0.53, 1.09]$, $p = 0.497$). Table 4 displays the post-hoc tests with p -values corrected for the false-discovery rate (Benjamini & Hochberg, 1995), where we found no difference in the intercept estimates at ± 1 SD of political orientation. We did observe a significant positive interaction of reactance and individual beliefs in predicting norms ($b = 0.07$, 95% CI = $[0.02, 0.16]$, $p = 0.009$), yet there was no direct association between reactance and perceived norms ($b = 0.08$, 95% CI = $[-1.98, 2.14]$, $p = 0.937$). Figure 2 visualizes the significant interaction. Table 5

displays the post-hoc tests with p -values corrected for the false-discovery rate, where we found no difference in the intercept estimates at ± 1 SD of reactance. The post-hoc tests for both models do not support hypothesis 1b that political orientation and reactance would affect the pluralistic ignorance effect from hypothesis 1a.

Table 4: Political Orientation Post-hoc Test

Poli_Or +/-1 SD	Difference from Mean	SE	df	T-Ratio	P-Value
+1 SD	0.726	1.066	276.62	0.681	0.497
-1 SD	-0.726	1.066	276.62	-0.681	0.497

Note: p-values adjusted for false-discovery rate

Table 5: Reactance Post-hoc Test

Reactance +/-1 SD	Difference from Mean	SE	df	T-Ratio	P-Value
+1 SD	0.084	1.067	276.3	0.079	0.937
-1 SD	-0.084	1.067	276.3	-0.079	0.937

Note: p-values adjusted for false-discovery rate

Figure 2: Reactance Interaction

Figure 2: Displayed are the data and interaction regression lines, with 95% confidence intervals, for the analysis that tested hypothesis 1b. We found a significant positive interaction of reactance and beliefs in predicting perceived norms, suggesting that the association between beliefs and perceived norms was stronger among those higher in psychological reactance.

Preregistered Hypothesis 1c

Hypothesis 1c was exploratory and predicted that the pluralistic ignorance effects from hypothesis 1a would be moderated by the specific preventive behaviors and the specific measures (importance vs. impact) participants were asked about. To test hypothesis 1c we ran two models where categorical fixed effects denoting either the five preventive behaviors or the two separate measures (importance and impact) were respectively added to the model for hypothesis 1a and allowed to interact with individual beliefs in predicting perceived norms. We then used post-hoc tests to examine pairwise differences in intercept estimates.

We found partial support for hypothesis 1c, such that significant pairwise differences in the pluralistic ignorance effect were observed across several of the five behaviors, but not across the important vs. impact distinction. Figure 3 displays the intercept estimates for each of the five preventive behaviors, and Table 6 contains the pairwise contrasts with p -values adjusted for the false-discovery rate. The largest pluralistic ignorance effect was observed for avoiding contact with friends, and the smallest pluralistic ignorance effect was observed for self-quarantining if sick. We found that eight of the ten pairwise contrasts between the behaviors were significantly different, supporting hypothesis 1c's prediction that the pluralistic ignorance effect would be moderated by the preventive behaviors being asked about. We did not however find that the measure of importance vs. impact affected the pluralistic ignorance effect. Post-hoc comparisons found no significant difference in intercept estimates across importance and impact measures (Impact - Importance = -0.33, SE = 0.63, $t(2506.77) = -0.53$, $p = 0.599$).

Figure 3: Mean Differences Between Beliefs and Perceived Norms

Figure 3: Displayed are the marginal intercept estimates for the model that tested hypothesis 1c. Zero here, noted with the blue dotted line, represents the mean of participants' personal beliefs, whereas the estimates

themselves are participants' perceived norms. Red bars are 95% confidence intervals. Estimates that differ from zero can be interpreted as evidence of pluralistic ignorance: perceived norms that are lower than individuals' own beliefs.

Table 6: Pairwise Comparisons by Behavior

Contrast	Estimate	SE	df	T-Ratio	P-Value
Contact - Friends	3.408	0.963	2504.097	3.539	0.001
Contact - Hand_Washing	-6.767	0.955	2503.533	-7.086	0.000
Contact - Leaving_Home	2.493	0.954	2501.905	2.613	0.011
Contact - Quarantine	-8.083	1.029	2519.023	-7.859	0.000
Friends - Hand_Washing	-10.175	0.968	2509.506	-10.510	0.000
Friends - Leaving_Home	-0.915	0.964	2503.018	-0.949	0.343
Friends - Quarantine	-11.491	1.044	2528.757	-11.007	0.000
Hand_Washing - Leaving_Home	9.260	0.958	2504.871	9.669	0.000
Hand_Washing - Quarantine	-1.316	1.027	2513.382	-1.281	0.222
Leaving_Home - Quarantine	-10.576	1.032	2521.742	-10.246	0.000

Note: p-values adjusted for false-discovery rate

Preregistered Hypothesis 2

Hypothesis 2 was confirmatory and predicted that both individual beliefs and perceived social norms would independently and positively predict participants' intentions to engage in COVID-19 preventive health behaviors. To test hypothesis 2 we utilized linear mixed effects modeling where behavioral intentions were modeled as the dependent variable and individual beliefs and perceived social norms were modeled as independent variables, with participants modeled as random intercepts to account for repeated measures across the five preventive behavior items and two importance/impact items.

Our analyses found only partial support for hypothesis 2. Although individual belief and perceived norms were positively associated with behavioral intentions when analyzed separately, in a full model only individual beliefs were associated with behavioral intentions. Table 7 displays the stepwise models testing hypothesis 2.

Table 7: Testing Hypothesis 2

Predictors	Intentions (Belief-Only Model)			Intentions (Norms-Only Model)			Intentions (Full Model)		
	b	CI	p	b	CI	p	b	CI	p
(Intercept)	-0.000	-1.717 – 1.717	1.000	2.508	0.500 – 4.516	0.015	0.507	-1.332 – 2.346	0.589
Beliefs	0.453	0.409 – 0.497	<0.001				0.442	0.396 – 0.487	<0.001
Norms				0.115	0.085 – 0.145	<0.001	0.023	-0.007 – 0.053	0.127
Random Effects									
σ^2	178.31			198.96			178.13		

T_{00}	196.22 _{ID}	241.89 _{ID}	197.19 _{ID}
ICC	0.52	0.55	0.53
N	279 _{ID}	279 _{ID}	279 _{ID}
Observations	2790	2790	2790
Marginal R^2 / Conditional R^2	0.112 / 0.577	0.017 / 0.557	0.111 / 0.578

Preregistered Hypothesis 3

Hypothesis 3 was exploratory and predicted that the participants' levels of pluralistic ignorance, measured as the within-participant difference between individual beliefs and perceived social norms, would be uniquely associated with behavioral intentions. We tested Hypothesis 3 using response surface analysis (RSA; Barranti et al., 2017; Shanock et al., 2010), a polynomial regression technique for examining how the difference between two variables predicts a third. RSA uses the polynomial regression estimates to graph the response-surface in 3-dimensional space, and computes four distinct dimensions of the response-surface (a^1 - a^4). The response-surface is plotted along the line-of-congruence, a slope line that denotes where all X-Y points (beliefs and norms) are perfectly equivalent, and the line-of-incongruence: a slope line that denotes where all X-Y points are perfectly opposite (i.e., if $X = 30$ then $Y = -30$). Parameter a^1 is the linear slope estimate, and a^2 the curvilinear slope estimate, for the line-of-congruence, whereas parameter a^3 is the linear slope estimate, and a^4 the curvilinear slope estimate, both for the line-of-incongruence. Of primary interest to hypothesis 3 is the a^4 estimate. For example, if a^4 were found to be significant and negative (indicating negative curvature on the line-of-incongruence), that would mean that individuals whose beliefs and norms diverge to a greater extent would have lower behavioral intentions.

We followed the procedure outlined by Barranti et al. (2017) for testing whether RSA was appropriate. We examined whether there were any significant polynomial predictors of behavioral intentions and whether a polynomial model significantly improved model fit compared to a linear fixed-effects only model. For the polynomial models, all variables were centered at the scale midpoint (50). Table 8 displays the results of the full polynomial model, where we find a significant and negative polynomial effect of individual beliefs in predicting behavioral intentions. We conducted a likelihood ratio test comparing this full polynomial model to the fixed-effects only model tested for hypothesis 2 and found that the polynomial model significantly improved model fit ($\chi^2(3) = 13.15, p = 0.004$). These results served primarily as a parameter check to ensure that conducting a response-surface analysis was appropriate.

Table 9: Testing Hypothesis 3

<i>Predictors</i>	Intentions		
	<i>b</i>	<i>CI</i>	<i>p</i>
(Intercept)	21.159	18.597 – 23.721	<0.001
Belief	0.556	0.477 – 0.635	<0.001
Norms	0.061	-0.013 – 0.135	0.106

COVID-19 SOCIAL NORMS

Belief^2	-0.003	-0.004 – -0.001	0.001
Norms^2	0.001	-0.000 – 0.002	0.289
Beliefs*Norms	-0.001	-0.003 – 0.001	0.212
Random Effects			
σ^2	177.36		
T _{00 ID}	197.84		
ICC	0.53		
N _{ID}	279		
Observations	2790		
Marginal R ² / Conditional R ²	0.112 / 0.580		

Having met the criteria suggested by Barranti et al. (2017) for plotting a response surface, we used the coefficients from the full polynomial model to calculate the response surface parameters (a^1 - a^4 , see Table 9) and visually plotted the response surface in 3-dimensions (see Figure 4). Figure 4 depicts the 3-dimensional space with two lines crossing it. The red line is the line-of-congruence, and the blue line is the line-of-*incongruence*: We found no significant curvature for the line-of-*incongruence* ($a^4 = -0.001$, $p = 0.474$), which suggests no evidence in support of hypothesis 3's prediction that the difference between individual beliefs and perceived norms would uniquely predict behavioral intentions.

Table 9: Response Surface Parameters

Parameter	Estimate	SE	T-Ratio	P-Value
$a1$	0.617	0.056	10.952	0.000
$a2$	-0.003	0.001	-2.817	0.005
$a3$	0.495	0.054	9.150	0.000
$a4$	-0.001	0.001	-0.716	0.474

Figure 4: Response Surface Plot

Figure 4: Displayed is the plotted response surface and data for the analysis that tested hypothesis 3 (see Tables 8 and 9 for detailed statistics). Beliefs and perceived norms are both centered at the scale midpoint of 50. The red line is the line-of-congruence, and the blue line is the line-of-incongruence. The color gradient of the response surface, detailed on the right-hand legend, reflects the raw values of behavioral intentions along the z-axis.

Exploratory Hypotheses

All the analyses presented below were not preregistered, or only mentioned as potential exploratory analyses in the preregistration (see: <https://osf.io/236cy>). While many analyses below are mentioned only briefly, they are all fully explicated in the R Markdown file on the OSF (<https://osf.io/hqd39/>).

In checking our model assumptions we found that the model used to test hypothesis 2 violated the assumption of normally distributed residuals (see Figure 5 for QQ plot). We employed several methods in our attempts to address this issue. First, we modeled hypothesis 2 using mixed-effects beta-regression (Smithson & Verkuilen, 2006), as our data were bounded and left-skewed. Second, we used Cook's Distance to remove 27 discrete responses that were identified as outliers. Third, we removed outlier participants based on the distribution of random intercept estimates by participants. None of these techniques notably improved the normality of residuals and none changed the results. In light of these issues we turned to a robust

linear-mixed model technique where residual outliers are down weighted in the regression (Koller, 2016). The results from the robust linear-mixed model did not change the findings of the preregistered analysis for hypothesis 2.

Figure 5: QQ Plot for H2 Model

Figure 5: Displayed is the QQ residual plot for the regression used to test hypothesis 2 (see Table 8's "Full Model" for detailed statistics). These data suggest that the model violates the assumption of normally-distributed residuals.

Because the remainder of our exploratory analyses relate to predicting behavioral intentions, all analyses below utilized the robust LMM technique used to address issues of non-normal residuals. It is nonetheless clear that issues of non-normal residuals reflect not a few outliers but the general pattern of observations: behavioral intentions and beliefs were highly left-skewed and largely at ceiling. 54.05% of belief responses, and 58.27% of intentions, were at 100 on our 0-100 scale. We strongly urge future researchers examining beliefs about and intentions to engage in COVID-19 preventive health behaviors to carefully consider their measurement approach and decide *a priori* how to handle issues of skewed responses.

Our preregistered analyses suggested that individuals' beliefs are the primary predictor of behavioral intention, and as such we investigated the role of several moderators in affecting this relationship. We entered each moderator as a fixed effect into the robust LMM with beliefs predicting behavioral intentions, and allowed the moderator to interact with beliefs. All robust LMMs utilized Wald tests to determine *p*-values.

In examining political beliefs, we found that political orientation (higher values = more right-wing) negatively interacted with beliefs ($b = -0.019$, 95% CI $[-0.024, -0.013]$, $p < 0.001$), suggesting that the linear association between beliefs and intentions is smaller among

participants who identify as more right-wing. For psychological reactance we found a similar negative interaction with beliefs ($b = -0.045$, 95% CI $[-0.061, -0.028]$, $p < 0.001$), but also found that reactance itself positively predicted behavioral intentions ($b = 0.62$, 95% CI $[0.131, 1.109]$, $p = 0.013$). Participants' financial stability positively interacted with beliefs ($b = 0.058$, 95% CI $[0.034, 0.073]$, $p < 0.001$), and participants' perceived risk of contagion was unrelated to behavioral intentions. We found that trust in both government and health officials was negatively associated with behavioral intentions but positively interacted with beliefs (see Table 10). Participant age was positively associated with behavioral intentions ($b = 0.083$, 95% CI $[0.035, 0.132]$, $p = 0.001$) and negatively interacted with beliefs ($b = -0.007$, 95% CI $[-0.009, -0.006]$, $p < 0.001$). Men, relative to women, reported lower behavioral intentions ($b = -1.387$, 95% CI $[-2.416, -0.357]$, $p = 0.008$), and gender positively interacted with beliefs ($b = 0.095$, 95% CI $[0.060, 0.131]$, $p < 0.001$), such that the association between beliefs and behavioral intentions was stronger for men.

Table 10: Robust LMMs for Trust in Gov/Health Officials

<i>Predictors</i>	Intentions (Trust in Gov)			Intentions (Trust in Health Officials)		
	<i>b</i>	<i>CI</i>	<i>p</i>	<i>b</i>	<i>CI</i>	<i>p</i>
(Intercept)	4.637	4.149 – 5.126	<0.001	4.693	4.210 – 5.175	<0.001
Beliefs	0.417	0.399 – 0.434	<0.001	0.415	0.398 – 0.432	<0.001
Trust in Gov Officials	-0.635	-0.954 – -0.316	<0.001			
Belief * Gov Trust	0.086	0.076 – 0.096	<0.001			
Trust in Health Officials				-0.620	-0.933 – -0.307	<0.001
Belief * Health Trust				0.079	0.069 – 0.089	<0.001
Random Effects						
σ^2	27.78			27.81		
τ_{00}	13.66 _{ID}			13.20 _{ID}		
ICC	0.33			0.32		
N	279 _{ID}			278 _{ID}		
Observations	2790			2780		
Marginal R^2 / Conditional R^2	0.486 / 0.656			0.494 / 0.657		

Discussion

This study found that individuals' beliefs about COVID-19 preventive health behaviors were notably stronger than their perceptions of the average American's beliefs, and that individuals' own beliefs were the only consistent positive predictor of intentions to engage in

such preventive behaviors. Contrary to our hypotheses 2 and 3 however, perceived social norms were not associated with behavioral intentions above individuals' own beliefs, nor did the self-other difference uniquely predict behavioral intentions.

A likely explanation for our findings is that perceived norms related to what the “average American” believes are not proximal enough to have an impact on behavioral intentions. For example, a recent preprint found that the perceived norms among family and friends are associated with COVID-19 preventive health behaviors (Goldberg et al., 2020). Our results could also reflect a “loose” culture of social norms in the United States (Gelfand, 2012), where individuals may be slower to adopt general norms that are newly developing. However, we argue that our findings are face-valid in the context of the worst global pandemic in decades (as of writing): individuals who strongly believe that preventive behaviors are important appear to ignore any normative pressures from psychologically-distant others they perceive as less concerned than themselves. Given the exceptional social nature of a global pandemic, we surmise that any effect of social norms on behavioral intentions will likely be observed with more psychologically-close reference groups. Whether or not this dynamic persists for more psychologically-proximate normative pressures, such as from in-group members, is a critical avenue for future research examining how perceived norms affect COVID-19 preventive health behaviors.

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Ethics

This research was approved by Harvard University's Institutional Review Board under protocol #20-0499. All participants provided informed consent to participate, and no deception or incomplete disclosure was utilized for this study.

Contributions

JL proposed the original research question, and all authors contributed equally in greatly refining the research idea and translating that into the final, preregistered study design. JL facilitated online data collection and baseline analyses, and prepared the first draft of the manuscript. All authors contributed equally in significantly editing and improving the manuscript draft.

References

- Barranti, M., Carlson, E. N., & Côté, S. (2017). How to test questions about similarity in personality and social psychology research: Description and empirical demonstration of response surface analysis. *Social Psychological and Personality Science*, 8(4), 465–475. <https://doi.org/10.1177/1948550617698204>
- Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67(1), 1–48. <https://doi.org/10.18637/jss.v067.i01>
- Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society: Series B (Methodological)*, 57(1), 289–300. <https://doi.org/10.1111/j.2517-6161.1995.tb02031.x>
- Bursztyn, L., Gonzalez, A. L., & Yanagizawa-Drott, D. (2018). Misperceived social norms: Female labor force participation in Saudi Arabia. *National Bureau of Economic Research Working Paper Series*.
- Cialdini, R. B., & Goldstein, N. J. (2004). Social influence: Compliance and conformity. *Annual Review of Psychology*, 55(1974), 591–621. <https://doi.org/10.1146/annurev.psych.55.090902.142015>
- Gelfand, M. J. (2012). Culture's constraints: International differences in the strength of social norms. *Current Directions in Psychological Science*, 21(6), 420–424. <https://doi.org/10.1177/0963721412460048>
- Glass, R. J., Glass, L. M., Beyeler, W. E., & Min, H. J. (2006). Targeted social distancing design for pandemic influenza. *Emerging Infectious Diseases*, 12(11), 1671–1681.
- Goldberg, M., Gustafson, A., Maibach, E., Linden, S. van der, Ballew, M. T., Bergquist, P., Kotcher, J., Marlon, J. R., Rosenthal, S. A., & Leiserowitz, A. (2020). *Social norms motivate COVID-19 preventive behaviors* [Preprint]. PsyArXiv. <https://doi.org/10.31234/osf.io/9whp4>
- Koller, M. (2016). robustlmm: An R package for robust estimation of linear mixed-effects models. *Journal of Statistical Software*, 75(6).
- Levendusky, M. S., & Malhotra, N. (2016). (Mis)perceptions of partisan polarization in the American public. *Public Opinion Quarterly*, 80(S1), 378–391. <https://doi.org/10.1093/poq/nfv045>
- Monin, B., & Norton, M. I. (2003). Perceptions of a fluid consensus: Uniqueness bias, false consensus, false polarization, and pluralistic ignorance in a water conservation crisis. *Personality and Social Psychology Bulletin*, 29(5), 559–567. <https://doi.org/10.1177/0146167203029005001>
- Prentice, D. A., & Miller, D. T. (1993). Pluralistic ignorance and alcohol use on campus: Some consequences of misperceiving the social norm. *Journal of Personality & Social Psychology*, 64(2), 243–256.
- Shanock, L. R., Baran, B. E., Gentry, W. A., Pattison, S. C., & Heggstad, E. D. (2010). Polynomial regression with response surface analysis: A powerful approach for examining moderation and overcoming limitations of difference scores. *Journal of Business and Psychology*, 25(4), 543–554. <https://doi.org/10.1007/s10869-010-9183-4>
- Smithson, M., & Verkuilen, J. (2006). A better lemon squeezer? Maximum-likelihood regression with beta-distributed dependent variables. *Psychological Methods*, 11(1), 54–71. <https://doi.org/10.1037/1082-989X.11.1.54>
- Sparkman, G., & Walton, G. M. (2019). Witnessing change: Dynamic norms help resolve

- diverse barriers to personal change. *Journal of Experimental Social Psychology*, 82, 238–252. <https://doi.org/10.1016/j.jesp.2019.01.007>
- Van Bavel, J. J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crockett, M. J., Crum, A. J., Douglas, K. M., Druckman, J. N., Drury, J., Dube, O., Ellemers, N., Finkel, E. J., Fowler, J. H., Gelfand, M., Han, S., Haslam, S. A., Jetten, J., ... Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*. <https://doi.org/10.1038/s41562-020-0884-z>