The Interactive Effects of Scientific Knowledge and Gender on COVID-19 Social Distancing Compliance

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Objective. In this research note, we examine the role scientific knowledge and gender plays in citizen responses to governmental social distancing recommendations. *Methods.* Using two waves of the American Trends Panel Survey and a measure of latent scientific knowledge, we test whether scientific knowledge is associated with comfort in participating in social activities during the COVID-19 pandemic within both the full U.S. population and the two major political parties. *Results.* In both the general population and within the Democratic Party, we find that women are generally more likely to use their scientific knowledge to inform their level of comfort with social activities during the COVID-19 pandemic. *Conclusion.* These findings shed light on how knowledge and gender intersect to drive compliance with government recommendations and policies during a public health crisis in a deeply partisan America.

Governmental Social Distancing Recommendations During the COVID-19 Pandemic

On March 11, 2020, the World Health Organization (WHO) recognized the Novel Coronavirus Disease 2019 (COVID-19) as a global pandemic and cautioned the international community about the risk of transmission. In response, local and state governments across the United States implemented social distancing measures to control disease contagion (Gupta et al., 2020). However, the willingness to comply with government mandates has varied significantly along partisan lines within the mass public (Algara, Fuller, and Hare, 2020). Much of the existing literature emphasizes that party identification is a potent and powerful force that shapes social distancing behavior and rhetoric (e.g., Grossman et al., 2020; Green et al., 2020). While partisanship is an important behavioral factor, it is unclear how other social characteristics, such as scientific knowledge and gender, influence disease contagion. Indeed, as concerns about COVID-19 transmission increase, it is important to understand the factors that motivate an individual's willingness to adhere to government recommendations.

In this article, we examine how scientific knowledge impacts the willingness to engage in basic activities during the shelter-in-place mandate. Second, we investigate these effects across partisan lines. The results suggest that scientific knowledge reduces the willingness to

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participate in more risky activities, but that these effects are only present among women. Interestingly, our results also reveal intraparty differences such that scientific knowledge increases the willingness for Republican men, not women, to adopt precautionary social distancing behavior. Overall, this article provides a more nuanced perspective on the individual behavioral factors that influence disease contagion.

How Scientific Knowledge Informs Personal Behavior

Perceptions of risk play a fundamental role in how people make decisions and often affect the likelihood that an individual adopts precautionary behavior (Slovic and Weber, 2011; Marra, Pannell, and Ghadim, 2003). Given the risks associated with COVID-19, we would expect that individual public support for and compliance with social distancing measures are likely influenced by that individual's perception of the pandemic's risk and their own level of risk preferences (risk-aversion vs. risk-acceptance). We should also expect that this behavior is influenced by the perception of risk posed to others interacted with that individual's own level of empathy or compassion (Brewer et al., 2004). Thus, reactions and behavioral responses to government recommendations, like social distancing, are consequences of how people perceive risk to themselves and others—in that those with high perceived risk and risk-averse preferences (as well as high levels of compassion) should be less willing or less comfortable to engage in a risky activity (Brewer et al., 2004; Sadique et al., 2007).

However, given the unprecedented nature of COVID-19, knowledge regarding the risks of the virus is mixed throughout the mass public (Bruine de Bruin and Bennett, 2020). With emerging issues the public must come to conclusions about both perceived risks and what constitutes appropriate individual and government responses (Cochran and Sanders, 2009). Furthermore, complex issues related to science—like climate change or a public health crisis—require high levels of scientific knowledge for informed preferences and behavior in the mass public (Funk and Goo, 2015). For example, climate change research finds that those with higher levels of education and scientific knowledge believe that climate change is more dangerous than those with lower levels of education (Sun and Han, 2018). Furthermore, more general research on scientific literacy suggests that informed policy preferences and decisions related to complex scientific issues, like public health crises, require a high degree of scientific knowledge (Pollock, Lilie, and Vittes, 1993).

Consequently, we would expect that scientific knowledge enables individuals to accurately perceive and understand the risks posed by COVID-19 not only for themselves but also for others. Without this knowledge, individuals may state that they are comfortable, for example, attending a crowded event whereas if they understood the risks they would be uncomfortable. That being said, many individuals also have risk-acceptant preferences and are, regardless of the perceived risks, comfortable with social behaviors. Finally, given that both knowledge of these risks and risk preferences themselves lay on a spectrum, some mix of these two characteristics could push individuals toward comfort or discomfort.

Overall, we argue that scientific knowledge enables people to better understand the hazards associated with COVID-19, both for themselves and others. Put differently, those with high scientific knowledge, risk-aversion, and possibly compassion should be more likely to follow social distancing guidelines so as to reduce their own risk of exposure and potentially reduce the risk to others as well.

The Conditioning Role of Gender

The extent to which scientific knowledge motivates risk perceptions and resulting behavior likely depends on other individual factors such as gender. Research on gendered differences in risk perceptions and preferences consistently finds that, on average, women are more risk-averse and are more likely to adopt precautionary measures relative to their male counterparts (Barke, Jenkins-Smith, and Slovic, 1997; Slovic, 1987; Linden, 2017). These differences are uniform across a number of different domains including vehicle accidents, stress, crime and violence, financial decision making, and public health concerns (Barke, Jenkins-Smith, and Slovic, 1997). In fact, studies show that men and women with similar understandings of scientific information still diverge in their risk perceptions (Barke, Jenkins-Smith, and Slovic, 1997; Slovic, 1987).

These findings imply that education and scientific knowledge alone do not capture risk perception. Rather, gender plays an important role in the relationship between scientific knowledge and risk perception. Thus, scholars have proposed a diverse set of theories to explain why women are more risk-averse than men (Steger and Witt, 1989; Firestone, 1970; Gilligan, 1982). For example, the socialization hypothesis posits that women have been socialized to be caregivers, while men have been engendered to care about the economy (Steger and Witt, 1989). Looking specifically at technology and science, Firestone (1970) reasons that women may have lower institutional trust in fields governed by men. Finally, a more prominent explanation is that women may view health and safety as their core responsibilities and thus express more concern over issues related to health and safety (Davidson and Freudenburg, 1996; Xiao and McCright, 2012).

Similarly, research has consistently identified a gender gap in policy preferences related to higher levels of compassion and empathy among women. Specifically, women support pro-social policies, such as greater access to healthcare and social welfare, because of their higher level of compassion and perception of higher government effectiveness than men (Cochran and Sanders, 2009; Schlesinger and Heldman, 2001; Shapiro and Mahajan, 1986). Importantly, this difference in compassion and empathy toward others along with women's belief that health and safety are their core responsibilities should inform their level of comfort participating in social activities. Simply put, women should be more likely than men to be uncomfortable with social behavior due to the potential risks that behavior has for other individuals, above and beyond concerns for their own well-being.

Given the clear health and safety concerns of COVID-19 and the expectation that women express greater concern over public health issues, more empathy toward others, and have a greater degree of risk-aversion than men, we anticipate that scientific knowledge should be more salient toward informing social distancing compliance during the COVID-19 pandemic for woman relative to men.

Potential Heterogeneity Among Partisans

The COVID-19 pandemic has struck the United States during a period of intense partisan and ideological polarization. Over recent decades, Democratic and Republican voters have become more antagonistic toward each other and increasingly reliant on party cues. Partisans have also grown more ideologically and culturally homogeneous, simultaneously divided across a wide range of demographic attributes, policy issues, value dispositions, and lifestyle preferences (DellaPosta, 2020; Gibson and Hare, 2016; Grossman et al., 2020).

In the context of the United States' polarized political system, however, COVID-19 presents an uncommon instance of a politically salient issue on which voters have few, if any, existing considerations to guide their support for policies or specific behaviors. The issue evolution literature has consistently found that partisan and ideological alignments on new issues is initially relatively unclear and unsettled (Cochran and Sanders, 2009). Thus, social distancing policies or guidelines are likely relatively technical or "hard" issues (Carmines and Stimson, 1980) that are informed by medical and epidemiological expertise. Simply put, it is more difficult for voters to determine their policy preferences and resulting behaviors regarding hard issues based on party or ideological lines unless elites are able to frame the issue in explicit terms of core values (Pollock, Lilie, and Vittes, 1993).

In this context, public opinion, and resulting behavior, should be relatively more influenced by nonpolitical information flows (Zaller, 1992). Hence, we expect that scientific literacy will play a larger role in shaping social distancing behavior than behavior relating to other scientific-based issues such as climate change (e.g., Kahan et al., 2012). However, given that Republican voters have received relatively anti-social distancing cues from Republican and conservative figures, we should expect a differential effect of scientific knowledge on social distancing behaviors between Democrats and Republicans (Green et al., 2020). In contrast, Democratic messaging has been consistent in advising individuals to adhere to social distancing guidelines its support of scientific experts and the need for significant interventions. Consequently, we would expect that Republicans, compared to independents and especially Democrats, should have comfort levels that are less responsive to their level of scientific knowledge.

Research Design

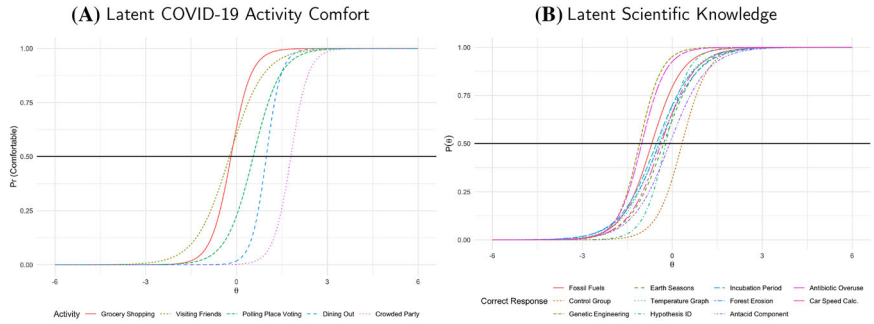
To evaluate our hypotheses, we rely on the nationally representative sample provided by Pew's American National Trends Panel Survey. Given potential concerns regarding endogeneity between the onset of the COVID-19 pandemic and scientific knowledge, we rely on panel wave 32 fielded from January 7−21, 2019, to measure our key independent variable of citizen scientific knowledge. To measure our outcome variables of interest, namely citizen compliance with government social distancing recommendations, we rely on panel wave 64 fielded from March 19−24, 2019. In this survey, respondents were asked if they felt comfortable doing the following activities:

1. attending a crowded a party;
2. eating out in a restaurant;
3. going to a polling place and vote;
4. going out to the grocery store;
5. visiting a close friend or family member at their home.

These outcome variables were coded as 1 if citizens felt comfortable doing such an activity or 0 if they felt uncomfortable. We also construct a composite measure of latent adherence to social distance policies using an item-response theory (IRT) model, with resulting respondent scores providing a measure of overall comfort in participating in nonsocial distancing activities. IRT models are a useful tool for measuring latent preferences or characteristics from a set of observed behaviors, with the canonical example being the measurement of students' abilities with multi-item tests. In this example, higher ability should correspond to a higher probability of a correct answer to a valid question. In political science, the IRT model has been applied to measure ideology, political knowledge, and other

FIGURE 1

Item Characteristic Curves of Activity Comfort and Latent Knowledge



latent concepts from a set of observed indicators (Armstrong et al., 2014).[1] As the results of the IRT model show in Figure 1A, the greater degree of latent restriction attitudes the more likely an individual is to express that government intervention in limiting social activities is necessary for containing the spread of COVID-19. The "hardest" policy to deem necessary was the postponement of state primary elections while the "easiest" policy was restricting international travel.

To measure citizen scientific literacy, we rely on 11 questions asking panelists objective questions concerning scientific facts and concepts. These questions are designed to test scientific literacy across the life and physical sciences domains (Miller, 1983; Kennedy and Hefferon, 2019). Given inherent variation in difficulty across questions, we treat scientific knowledge as a latent variable and measure it using a graded scale IRT model. Figure 1B shows the validity of our scientific knowledge measure by assessing the item characteristic curves of our composite measure. The *x*-axis articulates our measure of latent scientific knowledge and the *y*-axis articulates the probability of a current response for each of the questions assessing scientific knowledge.[2] As Figure 1B clearly shows, the greater the degree of latent knowledge the higher the probability of a correct response on each of the scientific knowledge questions, with clear variation in the difficulty of each question. For example, the easiest knowledge question to answer correctly concerned panelists' ability to correctly identify that the overuse of antibiotics can lead to antibiotic-resistant bacteria. By contrast, the hardest question to answer correctly dealt with identifying that the main components of antacids are bases. Lastly, to measure our conditioning variable of gender, we rely on self-reported panelist gender identification.[3]

Now that we have specified our key variables of interest, we turn to model specification. First, we specify the following baseline model to test whether scientific knowledge lowers activity comfort. The logistic regression model in Equation (1) tests whether scientific knowledge lowers the probability of being comfortable engaging in activities contrary to ideal social distancing guidelines. The regression model in Equation (2) tests whether scientific knowledge possesses an additive effect on comfort preferences:

$$\Pr(\text{Comfort}) = \log_{it}^{-1}\{\beta_0 + \beta_1 \times \text{Knowledge} + \beta_2 \times \text{Women} + \beta_i \times \text{Controls} + \varepsilon_{it}\} \tag{1}$$

[1]Latent comfort preferences are correlated at $\rho = 0.95$ with a summated comfort scale.
[2]Full scientific knowledge questions can be found in the Appendix.
[3]This is measured on a binary scale by Pew.

$$\text{Comfort} = \alpha + \beta_1 \times \text{Knowledge} + \beta_2 \times \text{Women} + \beta_i \times \text{Controls} + \varepsilon_{it}. \quad (2)$$

To test the conditional effect of scientific knowledge and gender on activity, we respecify the logistic regression model in Equation (1) and the regression model in Equation (2). In Equations (3) and (4), the models are respecified to include the interaction term of scientific knowledge and gender, allowing us to estimate how the effect of scientific knowledge varies by gender. We estimate a total of five logistic regression models for each activity panelists were asked to evaluate. Relatedly, Equation (4) allows us to estimate a regression model evaluating this interaction's effect on our composite measure of latent comfort preferences:

$$\begin{aligned}\Pr(\text{Comfort}) = \log_{it}^{-1}\{&\beta_0 + \beta_1 \times \text{Knowledge} + \beta_2 \times \text{Women} + \beta_3 \\ &\times(\text{Knowledge} \times \text{Women}) + \beta_i \times \text{Controls} + \varepsilon_i\} \quad (3)\end{aligned}$$

$$\begin{aligned}\text{Comfort} = \alpha + &\beta_1 \times \text{Knowledge} + \beta_2 \times \text{Women} + \beta_3 \\ &\times(\text{Knowledge} \times \text{Women}) + \beta_i \times \text{Controls} + \varepsilon_i. \quad (4)\end{aligned}$$

Our model includes standard behavioral model controls of partisanship, ideology, age, education, race, income, and regional context.[4] To explore variation in our effects of interest, we estimate the model by partisanship and for the full sample.[5] This allows us to not only see the overall conditional effect of scientific knowledge on comfort in various activities in defiance of social distancing but also how this effect is conditioned by gender across the full sample and by partisan affiliation.

Results by Activity Measure

Baseline Scientific Knowledge Effects

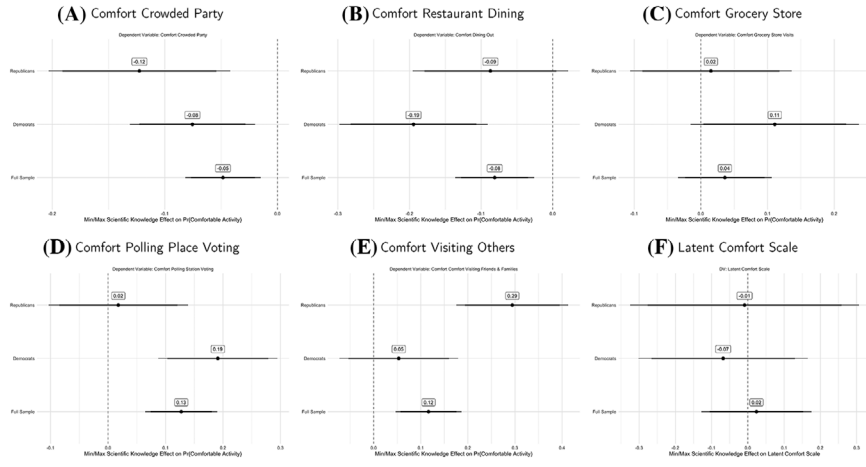
The results of Equations (1) and (2) exploring the additive effect of scientific knowledge on comfort in engaging in social activities are articulated in Figure 2. Each panel shows the effect of going from the minimum to the maximum value of scientific knowledge on comfort level for engaging in a given activity. This effect can be interpreted in terms of change in predicted probability of expressing comfort in the activity for panels A through E. For panels F through G, this effect can be interpreted as standard linear model coefficients. For the full sample, scientific knowledge significantly *lowers* the probability of expressing comfort in attending a crowded party and restaurant dining by 5 and 8 percent, respectively. However, knowledge significantly *raises* the probability of expressing comfort in polling place voting and by visiting others by 13 and 12 percent, respectively. For Republicans, this significant negative effect of knowledge on activity comfort holds at −12 percent

[4]Note that when using a summated rating scale aggregating each of the activities, we specify Equations (2) and (4) with a Poisson regression model given that this aggregation creates a count of the number of activities a panelist feels comfortable engaging in during the COVID-19 pandemic.

[5]The full model description can be found in the Appendix. Note that the state of residence is unavailable in the release Pew American Trends Survey. Models specified with survey weights.

FIGURE 2

Baseline Model Effects of Scientific Knowledge by Activity



in the context of attending a crowded party. For Democrats, this significant negative effect holds in the context of attending a crowded party and restaurant dining at −8 and −19 percent, respectively. Interestingly, knowledge significantly raises the probability of visiting others for Republicans by 29 percent and for polling place voting by 19 percent for Democrats. [6]

Surprisingly, null effects of scientific knowledge on comfort are found for the full sample, Republicans, and Democrats for grocery store visits and for the two aggregate measures of a comprehensive comfort scale. This suggests that scientific knowledge informs comfort in social activities for only a select few contexts and not in general across daily life.

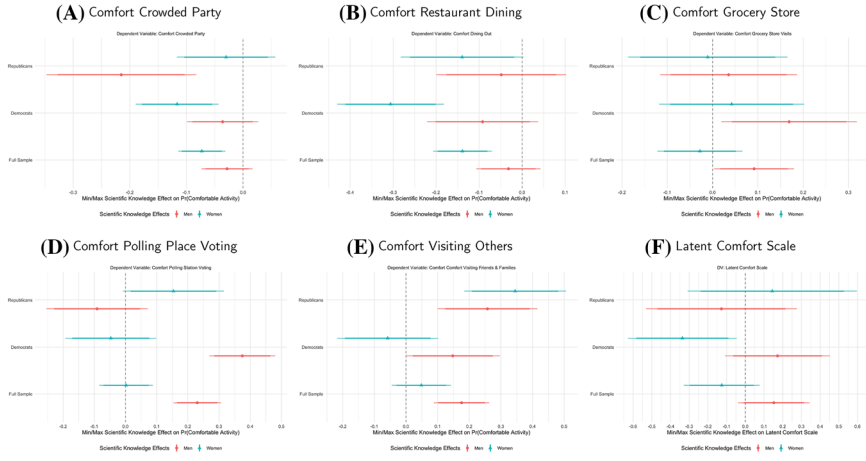
Conditioning Role of Gender on the Scientific Knowledge Effects

We turn to Figure 3 to report the results of our interactive models assessing how gender conditions the effect of scientific knowledge on comfort engaging in social activities. There is mixed evidence that gender significantly conditions the effect of knowledge for the full sample, Democrats, and Republicans. Turning to the full sample, there is evidence that gender conditions the effect of knowledge across activities. For attending a crowded party and restaurant dining, knowledge reduces the probability of expressing comfort engaging in these activities among women but *not* men by 7 and 14 percent, respectively. For polling place voting, visiting others, and grocery store visits, knowledge does increase the probability of expressing comfort for men rather than women by 23, 18, and 9 percent. Among Democrats, similar trends emerge with knowledge lowering comfort among women for attending a crowded party and restaurant dining at −12 and −31 percent. Interestingly, Democratic men are also more likely to express comfort in grocery story visits (17 percent) and polling place voting (38 percent). Among Republicans, largely null knowledge effects are found with the exception of attending a crowded party and comfort visiting others. In

[6]This approach provides for a total of $N = 18$ models evaluated in the additive and interactive specifications.

FIGURE 3

Baseline Model Effects of Scientific Knowledge by Activity



these two activities, knowledge increases the probability of expressing comfort in visiting others by 26 percent and decreases the probability of comforted in attending a crowded party by 22 percent among Republican men. For Republican women, knowledge only significantly affects comfort within the context of visiting others, with knowledge increases this probability by 35 percent.

Lastly, in evaluating the models assessing the effect of knowledge on the latent comfort scale measure, greater knowledge significantly decreases activity comfort for Democratic women. The effect is insignificant in the baseline models and for men and women within the full sample and Republican partisan specification. This lends comprehensive evidence that scientific knowledge plays an active role shaping comfort in nonsocial distancing activities in specific contexts rather than across activities.

Conclusion and Future Work

In this research note, we assess the extent to which scientific knowledge helps inform citizen responses to governmental social distancing guidelines and policies. In both the general population and within the parties, we find evidence that higher levels of scientific knowledge are associated with lower levels of comfort of performing non socially-distancing tasks such as attending a crowded party. We also find that higher levels of scientific knowledge are associated with less comfort in restaurant dining among the full sample and Democrats. Interestingly, we find the opposite effects for polling place voting and visiting others. Indeed, knowledge increases the comfort of in-person voting for Democrats and the full sample while it increases the comfort in visiting others for the full sample and Republicans. Our research note also finds evidence that the effect of scientific knowledge varies by gender. In the 18 models evaluated, knowledge significantly decreases activity comfort in six models for women and only a single model for men.[7] Contrary to our theoretical

[7]This negative and significant effect for women is apparent in two baseline models, four Democratic models, and one Republican model.

expectations, we find that higher knowledge increases the comfort of visiting others for both Republican men and women.

As the COVID-19 pandemic continues to shape state and federal responses in the United States, future work should continue to address potential sources of partisan variation in response to social distancing guidelines. In this article, we sought to understand just one potential source of this heterogeneity, scientific knowledge, and how this source varies across gender. More work should leverage additional considerations that could shape how citizens respond to social distancing guidelines, particularly cross-nationally as other governments seek to contain the pandemic.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Supplemental Appendix