Openness Relates to COVID-19 Vaccination Rates across 48 United States but Politics Trump Personality

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Abstract

Does geographic variation in personality across the United States relate to COVID-19 vaccination rates? To answer this question, we combined multiple state-level datasets: (a) Big Five personality averages (i.e., extraversion, agreeableness, conscientiousness, neuroticism, and openness; Rentfrow et al., 2008), (b) COVID-19 full-vaccination rates (CDC, 2021a), (c) health-relevant demographic covariates (population density, per capita gross domestic product, and racial/ethnic data; Webster et al., 2021), and (d) political and religiosity data. Analyses showed openness as the strongest correlate of full-vaccination rates (r = .51). Controlling for other traits, demographic covariates, and spatial dependence, openness remained significantly related to full-vaccination rates (r_p = .55). Adding political and religiosity data to this model diminished openness effects for full-vaccination rates to non-significance (r_p = .26); however, extraversion emerged as a significant correlate of full-vaccination rates (r_p = .37). Although politics are paramount, we suspect that states with higher average openness scores are more conducive to novel thinking and behavior—dispositions that may be crucial in motivating people to take newly-developed vaccines based on new technologies to confront a novel coronavirus.

Keywords: Big Five personality; COVID-19; Political behavior; Psychological geography; Religiosity; Spatial regression; United States; Vaccination

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A persistent challenge of the COVID-19 pandemic has been convincing people to get vaccinated. In countries that have access to available COVID-19 vaccines, regional variation in vaccine compliance and refusal abounds. For example, in the U.S., urban (vs. rural) counties often have higher vaccination rates (Murthy et al., 2021). Because Big Five personality traits have implications for health (Heilmayr & Friedman, 2020), we examined associations between state-level Big Five personality trait averages—extraversion, agreeableness, conscientiousness, neuroticism, and openness—and state-level vaccination rates among the 48 contiguous United States.

Personality traits correlate with—or even predict—multiple important health behaviors and outcomes (Heilmayr & Friedman, 2020; Jokela et al., 2013; Takahashi et al., 2013). Pertinent to the present work, data on Big Five traits and personal vaccine attitudes are mixed, with some studies finding small but significant positive correlations between most Big Five traits attitudes favoring vaccination (Lin & Wang, 2020) and others finding no substantial relations between Big Five traits and vaccination attitudes (Lee et al., 2017). Similar mixed evidence emerges predicting COVID-19 vaccination from Big Five traits (Murphy et al., 2021; Halstead et al., 2021). Moreover, "dark" personality traits related to line-cutting during the U.S.'s COVID-19 vaccine rollout (Howell et al., 2023).

Nevertheless, meaningful personality variation exists at regional levels, averaging across people. For example, geographic differences in personality relate to political, socioeconomic, and health outcomes (Rentfrow et al., 2013), and even fertility rates

(Junkins et al., 2021). Regarding COVID-19 infection rates and deaths—but not vaccinations—recent research has shown that regional variation in the Big Five traits correlated with rates in thousands of U.S. counties and hundreds of German administrative districts (Peters et al., 2023). In both countries, extraversion and openness positively related to earlier COVID-19 onsets and growth, whereas neuroticism negatively related to the same; extraversion and agreeableness positively related to cumulative infection rates, whereas openness positively related to death rates (Peters et al., 2023). Thus, there may be regional personality trait contexts (e.g., places that are particularly open to experience) that relate to population-level COVID-19 behavioral health outcomes. We examined the extent to which variability in state-level Big Five trait averages related to differences in *actual* state-level COVID-19-*vaccination* rates.

Hypotheses

We drew on prior related work or made best guesses regarding the directionality of each Big Five trait. Nevertheless, because we did not preregister our hypotheses, they should be considered exploratory (vs. confirmatory). Specifically, we hypothesized that each U.S.-state-level Big Five average would relate positively to actual statewide vaccinations rates:

1. *Extraversion*—because more outgoing people will want to resume their active social lifestyles (H1).
2. *Agreeableness*—because compliance is considered a core facet or component of agreeableness (Costa et al., 1991; H2).
3. *Conscientiousness*—because people higher on conscientiousness take health-related preventative action (Jokela et al., 2013; H3).

4. *Neuroticism*—because people who are more anxious about contracting or spreading COVID-19 might be more likely to seek vaccination (H4).
5. *Openness*—because the vaccines are new, and most use newly-authorized medical technology, people who are more open to (new) experiences are more likely to take vaccination action (H5).

Method

We combined five sources of archival, publicly available, U.S.-state-level data: vaccination rates, Big Five data, relevant demographic covariates, voting data, and religiosity.

Sample and Measures

Vaccination Rates

From *The New York Times* (December 28, 2021), we obtained CDC (2021a) data during the final week of 2021, about 54 weeks after mass vaccinations began (December 14, 2020), including both single- and two-dose vaccine regimens. Data included percent of people receiving at least *one dose* of a two-dose vaccine and percent who are *fully vaccinated* (≥1 dose of Johnson & Johnson or ≥2 doses of Moderna or Pfizer–BioNTech. Because these vaccination measures were highly correlated .93 (95% CI [.87, .96]), we focus on full-vaccination rates (Figure 1); findings focused on at least one dose, which were largely similar, appear in an online supplement: https://osf.io/k94vy/?view_only=b0c8a933705d407ebd30a181207288e0

Big Five Personality Traits

We used standardized (*z*-scored) state-level Big Five personality averages from the Gosling–Potter Internet Personality Project (Rentfrow et al., 2008's Table 1, p. 351). The original sample included 619,397 people (55% female; 80.2% White; median age 24

years, *SD* = 9.8); our subsample (Figure 2), which excluded Alaska, Hawaii, and the District of Columbia, consisted of 48 state averages based on 609,985 people (98.5%). Personality traits were assessed using the 44-item Big Five Personality Inventory (BFI; John & Srivastava, 1999; 1 = *disagree strongly* to 5 = *agree strongly*). U.S.-state Big-Five-personality averages are remarkably stable over time (Elleman et al., 2018).

Demographic Covariates

We examined the same state-level demographic covariates used in prior COVID-19 research including log population density, log per-capita gross domestic product (GDP), and percentage of non-White residents (positively skewed distributions necessitated log-transforming the first two variables; see Webster et al., 2021). We controlled for population density because rural areas have greater vaccination hesitancy (Murthy et al., 2021). We controlled for per capita GDP because people in poorer states often have less access to health care (Pickett & Wilkinson, 2015), and thus less access to vaccines. We controlled for a state's racial/ethnic Whiteness for two reasons but remained agnostic about its direction: Some (especially rural) White and some Black people are vaccine-hesitant because of federal government mistrust, albeit for different reasons (personal liberty for White people, prior governmental maltreatment for Black people; e.g., the Tuskegee Syphilis Study; CDC, 2021b; National Public Radio, 2021).

Politics and Religiosity

We used each state's voting behavior—percentage of Donald Trump (Republican presidential nominee) votes in 2020—as a measure of conservative political orientation (Cook Political Report, 2020). Regarding religiosity, we used each state's percent of "highly religious" adults (Pew Research Center, 2016).

Data Analysis and Power

We examined associations between state-level Big Five traits and vaccination rates using multiple regressions. We controlled for spatial dependence among the 48 contiguous U.S. states by using spatial regression (Ebert et al., 2021; Ward & Gleditsch, 2008). Controlling for spatial dependence is essential because adjacent states (e.g., Alabama and Georgia) tend to be more similar to one another than they are to a more distant state (e.g., Oregon), and ignoring this non-independence violates the independence-of-errors (or residuals) assumption of general linear models. Thus, we used a binary adjacency matrix (see Webster et al., 2021) that reflected which 48 states shared borders to create spatial lag variables for both vaccination rate outcomes. Because our sample size was limited to 48 states, we had adequate power (≥ .80) to detect effects sizes of $|r| \geq .33$ at $\alpha = .05$, two-tailed.

Sample size was limited to the 48 contiguous United States. Consistent with Webster et al. (2021), we excluded (a) Alaska and Hawaii because of our spatial regression approach, which does not allow isolates (states that border no others); and (b) the District of Columbia because it is not a state. Data and analysis code are available via OSF: https://osf.io/k94vy/?view_only=b0c8a933705d407ebd30a181207288e0

Results

Bivariate Correlations

For bivariate correlations (Table 1), only H5—positive associations for openness—was supported: Greater openness correlated with higher full-vaccination rates (.51 [.27, .70]; Figure 3). Contrary to our hypotheses, full-vaccination rates correlated significantly negatively with agreeableness (-.29 [-.53, -.00]) and conscientiousness (-.39 [-.60, -.11]).

Regression Results

We regressed full vaccination rates onto the Big Five state averages (Model 1), added demographic covariates (Model 2), and then added politics and religiosity (Model 3; Table 2). In Model 1 ($R^2 = .45$, $p < .001$) conscientiousness was negatively related to full vaccination rates ($r_p = -.44$), whereas extraversion ($r_p = .32$) and openness ($r_p = .59$) were positively related to full vaccination rates; both H1 and H5 were supported. In Model 2 ($R^2 = .72$, $p < .001$), after adding covariates, only openness remained significant ($r_p = .55$), again supporting H5. The spatial lag was significant ($r_p = .59$), suggesting similar rates of full vaccination in neighboring states. In Model 3 ($R^2 = .87$, $p < .001$), the spatial lag ($r_p = .35$) was significantly related to full vaccination, as was the Trump-2020-vote percentage ($r_p = -.66$); however, extraversion was also related to full vaccination rates ($r_p = .37$; H1).

Discussion

Although we hypothesized that all U.S. state-level Big Five traits would positively relate to state-level vaccination rates, multiple regressions controlling for relevant covariates showed only one trait—openness to experience—systematically supported one of our hypotheses (H5) prior to controlling for politics and religiosity. Although the BFI-44's openness items generally stress creativity, curiosity, imagination, and interest in the arts, at least five items also touch on novel thought or action ("is ingenious, a deep thinker"; "likes to reflect, play with ideas"; "is original, comes up with new ideas"; "is inventive"; "prefers work that is routine" [reverse-scored]). These items relating to novel cognition and behavior may drive state-level associations linking openness with higher vaccination rates. In the U.S., some have been hesitant to receive the vaccines in part because they are *new*, or based on *newly advanced* mRNA technology to quell a *novel* coronavirus. Thus, people's ability to be open to new ways of thinking about vaccination

and taking action to do so are likely contributing factors in their decisions to get vaccinated. Extraversion also emerged as a correlate of full vaccination rates in Model 3, suggesting that sociality or being outgoing may motivate people to seek vaccination, even after accounting for their politics.

Relating our results to prior work on COVID-19 infection rates (see Peters et al., 2023) suggests that both openness and extraversion may play dual roles over time. Regions with higher openness or extraversion may have people more willing to flout lockdown restrictions and hence spread infection; however, these same regions—or the people in them—may be among the first to adopt a new vaccine regimen.

That politics—voting for a conservative party—trumped openness as a correlate of vaccination behavior is unsurprising given that openness is often the strongest Big Five correlate of liberal/progressive political orientations (Rentfrow et al., 2009), and liberals/progressives are more likely to get COVID-19 vaccinations (Latkin et al., 2021). Although people's political identities likely influence their choice to get vaccinated, openness likely influences both political attitudes and health decisions over time.

Strengths, Limitations, Constraints on Generality, and Future Directions

Our findings have multiple limitations. First, the present work is a secondary data analysis achieved by combining archival data; we had no control over primary data collection. Still, this allowed us to merge summary, state-level data from a large sample with actual vaccination rates. Another strength is that these data show temporal precedence because the personality data were collected prior to vaccine availability; of course, temporal precedence is necessary but not sufficient for establishing causality (Kenny, 2004). Second, although our findings support openness–vaccination links at the U.S. *state* level, this may not be the case at the *person* level. Third, our findings only

generalize to the 48 contiguous United States (Henrich et al., 2010; Simons et al., 2017). Fourth, because the Big Five traits were intercorrelated, some multicollinearity was present, resulting in some partial correlations having different signs than their bivariate correlations (e.g., Extraversion r = -.23 to r_p = .37), which may indicate a suppression effect (MacKinnon et al., 2000). Although most personality psychologists examine the Big Five traits as a set (e.g., Webster et al., 2021), their bivariate associations with health outcomes should not be ignored.

Regarding implications, the present findings suggest that interventions aiming to promote vaccination might consider committing more resources to states on the lower ends of the openness and extraversion spectra, because people in those states are less likely to have been vaccinated. Of course, the states scoring highest on the openness and extraversion spectrum may be the exact same states or regions to experience early increases in infections in the next epidemic—or eventual pandemic (see Peters et al., 2023)—suggesting promoting early vaccination there might be key.

Conclusions

Combining multiple data sources on U.S. state-level Big Five personality traits and vaccination rates suggest that openness to experience positively relates to—and temporally precedes—higher COVID-19-vaccination rates. But controlling for political behavior and religiosity trumped the openness effects; only extraversion emerged as a positive correlate of full vaccination. We believe that our core finding of an openness–vaccination link among the 48 contiguous United States—notwithstanding politics and religiosity—may shed light on the important public health implications of considering regional differences in average personality traits.

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Table 1. *Means, Standard Deviations, and Correlations*

Variable	Mean	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
1. Full vaccination (%)	60.12	8.53												
2. Extraversion	0.01	0.97	-.23											
3. Agreeableness	0.13	0.74	**-.29**	**.54**										
4. Conscientiousness	0.11	0.89	**-.39**	**.36**	**.59**									
5. Neuroticism	0.05	1.01	.14	-.21	-.27	**-.44**								
6. Openness	-0.01	0.87	**.51**	**-.62**	**-.36**	-.10	.08							
7. One dose spatial lag	70.18	9.22	**.75**	-.24	**-.40**	**-.56**	**.37**	**.29**						
8. Full vax spatial lag	59.58	6.62	**.73**	-.25	**-.38**	**-.55**	**.36**	.25	**.93**					
9. GDP per capita (log)	10.73	0.18	**.49**	.01	-.21	**-.34**	-.10	.06	**.35**	**.48**				
10. Pop. density (log)	4.61	1.25	**.44**	-.26	-.16	-.28	**.51**	**.43**	**.40**	**.45**	.22			
11. Non-White pop. (%)	30.77	14.60	.05	-.07	-.13	**.30**	-.05	**.32**	-.17	-.17	.11	**.32**		
12. Trump 2020 vote (%)	50.37	10.28	**-.86**	**.32**	.23	.25	-.07	**-.62**	**-.58**	**-.58**	**-.46**	**-.54**	**-.33**	
13. Religiosity (%)	55.06	10.81	**-.72**	.20	**.31**	**.41**	.09	**-.30**	**-.67**	**-.68**	**-.48**	-.11	.28	**.64**

Note. $N = 48$ contiguous United States (i.e., excluding Alaska and Hawaii). Full vaccination: Either two doses of Pfizer/Moderna or one dose of Johnson & Johnson. GDP: Gross domestic product. Pop.: Population. **Boldface** correlations (≥ .285 in absolute magnitude) are significant at $p < .05$, two-tailed.

Table 2. *Multiple Regression Results: Full Vaccination Rates (%)*

					95% CI	
Variable	*b*	*t*	*p* ≤	r_p	LL	UL
Model 1: Big 5						
Extraversion	3.175	2.18	.035	.32	.02	.57
Agreeableness	0.586	0.32	.750	.05	-.26	.35
Conscientiousness	-4.715	-3.19	.003	-.44	-.66	-.16
Neuroticism	-0.374	-0.35	.730	-.05	-.35	.25
Openness	6.931	4.74	.000	.59	.35	.76
Model 2: Demographics						
Extraversion	2.064	1.84	.074	.28	-.04	.55
Agreeableness	1.187	0.76	.454	.12	-.21	.43
Conscientiousness	-1.650	-1.16	.254	-.18	-.48	.14
Neuroticism	-0.740	-0.72	.479	-.12	-.42	.21
Openness	5.088	4.02	.000	.55	.27	.74
Spatial lag	0.752	4.45	.000	.59	.33	.76
GDP per capita (log)	6.219	1.10	.277	.18	-.15	.47
Population density (log)	-0.116	-0.12	.902	-.02	-.34	.30
Non-White population (%)	0.028	0.39	.702	.06	-.26	.38
Model 3: Politics/Religiosity						
Extraversion	1.909	2.37	.023	.37	.04	.61
Agreeableness	-1.171	-0.95	.350	-.16	-.46	.18
Conscientiousness	-0.148	-0.14	.887	-.02	-.35	.31
Neuroticism	0.088	0.11	.911	.02	-.31	.35
Openness	1.686	1.62	.115	.26	-.07	.54
Spatial lag	0.327	2.21	.034	.35	.02	.60
GDP per capita (log)	1.893	0.47	.644	.08	-.26	.40
Population density (log)	-0.479	-0.71	.482	-.12	-.43	.22
Non-White population (%)	-0.126	-1.84	.073	-.29	-.57	.04
Trump 2020 vote (%)	-0.652	-5.21	.000	-.66	-.81	-.42
Highly religious adults (%)	0.054	0.48	.636	.08	-.26	.40

Note. N = 48 contiguous United States (i.e., excluding Alaska and Hawaii). GDP = Gross domestic product.

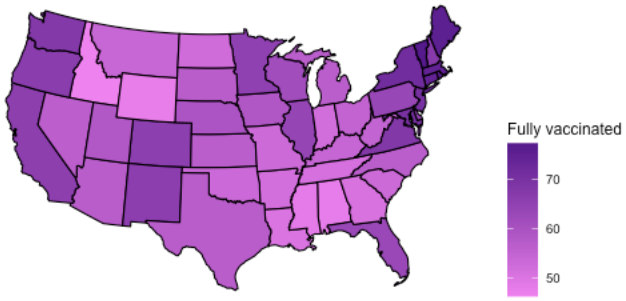

Figure 1. Statewide percentage of people who were fully vaccinated against COVID-19 as of December 28, 2021.

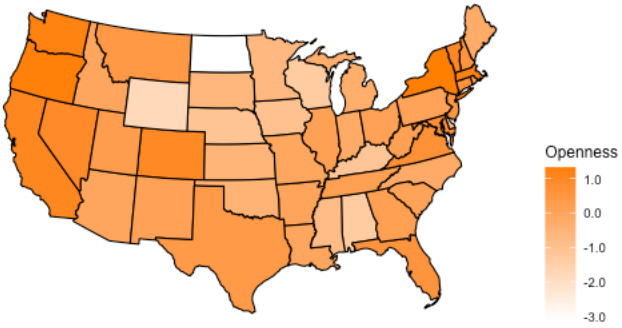

Figure 2. Openness to experience standardized (*z*-scored) averages for each state based on data from Rentfrow et al. (2008, Table 1, p. 351).

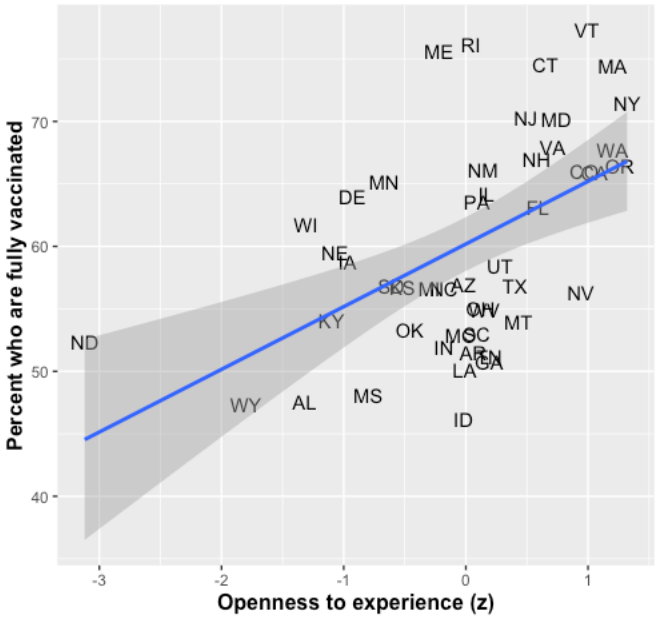

Figure 3. Bivariate correlation (with ordinary least-squares best-fit line and 95% CI) between state-level openness to experience and percent of people who are fully vaccinated against the COVID-19 vaccine as of December 28, 2021.