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

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Manuscript under Review

March 1, 2023

Word count total: 2,500 (text: 1,843; tables: 657)

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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 three state-level datasets: (a) Big Five personality averages (Rentfrow et al., 2008), (b) COVID-19 vaccination rates for those receiving at least one dose and fully vaccinated people (CDC, 2021a), (c) health-relevant demographic covariates (population density, per capita GDP, and racial/ethnic data; Webster et al., 2021), and (d) political and religiosity data. Correlations showed openness as the strongest predictor of both at-least-one-dose ($r = .50$) and full-vaccination ($r = .51$) rates. Controlling for other traits, demographic covariates, and spatial dependence, openness remained a significant predictor of both at-least-one-dose ($r_p = .33$) and full-vaccination ($r_p = .55$) rates. Adding political and religiosity data to this model diminished openness effects for both at-least-one-dose ($r_p = .11$) and full-vaccination ($r_p = .26$) rates to non-significance; however, extraversion emerged as a significant correlate of full vaccination ($r_p = .37$). 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 averages 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). In other words, there may be regional personality trait contexts

(e.g., places that are particularly open to experience) that relate to population-level behavioral health outcomes. Thus, 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

On an exploratory basis, 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). Data included percent of people receiving at least *one dose* of a two-dose vaccine (Figure 1) and percent who are *fully vaccinated* (≥ 1 dose of Johnson & Johnson or ≥ 2 doses of Moderna or Pfizer–BioNTech; Figure 2).

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 3), 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, per-capita gross domestic product (GDP), and percentage of non-White residents (Webster et al., 2021). We controlled for population density because rural areas have greater vaccination hesitancy (Murphy 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 Trump votes in 2020—as a measure of 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). 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 ($\geq .80$) to detect effects sizes of $|r| \geq .33$ at $\alpha = .05$, two-tailed.

We did not preregister this study. All hypotheses were exploratory. 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

State-level one-dose vaccination rates correlated with rates full vaccination rates (.93, 95% CI [.87, .96]). For bivariate correlations (Table 1), only H5—positive

associations for openness—was supported: Greater openness correlated with higher at-least-one-dose- (.50 [.26, .69]; Figure 4) and full-vaccination rates (.51 [.27, .70]; Figure 5). Contrary to our hypotheses, at-least-one-dose vaccination correlated significantly negatively with extraversion (-.30 [-.53, -.01]), agreeableness (-.32 [-.55, -.03]), and conscientiousness (-.34 [-.57, -.06]). In addition, full-vaccination rates correlated significantly negatively with agreeableness (-.29 [-.53, -.00]) and conscientiousness (-.39 [-.60, -.11]).

Regression Results

We regressed each vaccine rate outcome onto the Big Five state averages (Model 1), added demographic covariates (Model 2), and then added politics and religiosity (Model 3). Although we use the term “predicted,” links between the Big Five traits and vaccination rates can only show association and temporal precedence, not causality.

At Least One Dose

Table 2’s left half shows the regression results for the percentage of people in each state who have received at least one dose of vaccine. In Model 1 ($R^2 = .36$, $p = .002$), conscientiousness negatively ($r_p = -.30$)—and openness positively ($r_p = .49$)—predicted one-dose vaccine rates; only H5 was supported. In Model 2 ($R^2 = .77$, $p < .001$), after adding demographic covariates, only openness remained significant ($r_p = .33$), again supporting H5. The spatial lag ($r_p = .73$) and log GDP per capita ($r_p = .36$) were also significant, suggesting that at-least-one-dose-vaccination was similar for neighboring states and higher among wealthier states. In Model 3 ($R^2 = .82$, $p < .001$), other than the spatial lag ($r_p = .56$), only the Trump-2020-vote percentage ($r_p = -.35$) significantly predicted at-least-one-dose-vaccination rates.

Fully Vaccinated

Table 2's right half shows the regression results predicting percentage of people who have been fully vaccinated. In Model 1 ($R^2 = .45, p < .001$) conscientiousness was a negative predictor ($r_p = -.44$), whereas extraversion ($r_p = .32$) and openness ($r_p = .59$) were positive predictors; 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 a significant predictor of full vaccination, as was the Trump-2020-vote percentage ($r_p = -.66$); however, extraversion also emerged as a significant predictor ($r_p = .37$; H1).

Discussion

Although we predicted that all U.S. state-level Big Five traits would be positive predictors of 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 predictor of full vaccination in Model 3, suggesting that sociality or being outgoing may motivate people to seek vaccination, even after accounting for their politics.

That politics trumped openness as a predictor 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 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 influence 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. Although no substitute for establishing causal processes, another strength is that these data show temporal precedence because the personality data were collected prior to vaccine availability. 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).

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 predictor 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	13
1. One dose	70.51	10.84													
2. Full vax	60.12	8.53	-.93												
3. Extraversion	0.01	0.97	-.30	-.23											
4. Agreeableness	0.13	0.74	-.32	-.29	.54										
5. Conscientiousness	0.11	0.89	-.34	-.39	.36	.59									
6. Neuroticism	0.05	1.01	.15	.14	-.21	-.27	-.44								
7. Openness	-0.01	0.87	.50	.51	-.62	-.36	-.10	.08							
8. One dose spatial lag	70.18	9.22	.77	.75	-.24	-.40	-.56	.37	.29						
9. Full vax spatial lag	59.58	6.62	.77	.73	-.25	-.38	-.55	.36	.25	.93					
10. GDP per capita (log)	10.73	0.18	.48	.49	.01	-.21	-.34	-.10	.06	.35	.48				
11. Pop. density (log)	4.61	1.25	.44	.44	-.26	-.16	-.28	.51	.43	.40	.45	.22			
12. Non-White pop. (%)	30.77	14.60	.11	.05	-.07	-.13	.30	-.05	.32	-.17	-.17	.11	.32		
13. Trump 2020 vote (%)	50.37	10.28	-.81	-.86	.32	.23	.25	-.07	-.62	-.58	-.58	-.46	-.54	-.33	
14. Religiosity (%)	55.06	10.81	-.69	-.72	.20	.31	.41	.09	-.30	-.67	-.68	-.48	-.11	.28	.64

Note. $N = 48$ contiguous United States (i.e., excluding Alaska and Hawaii). One dose: At least one vaccine dose. Full vax: Fully vaccinated (either two doses of Pfizer/Moderna or one dose of Johnson & Johnson). GDP: Gross domestic product. Pop.: Population. TRUMPPCT=Percent voting for Trump in 2020. **Boldface** correlations ($\geq .285$ in absolute magnitude) are significant at $p < .05$, two-tailed.

Table 2. *Multiple Regression Results*

Variable	At least one vaccine shot (%)						Fully vaccinated (%)					
	<i>b</i>	<i>t</i>	<i>p</i> ≤	<i>r</i> _p	95% CI		<i>b</i>	<i>t</i>	<i>p</i> ≤	<i>r</i> _p	95% CI	
					LL	UL					LL	UL
Model 1: Big 5												
Extraversion	2.311	1.15	.255	.18	-.14	.45	3.175	2.18	.035	.32	.02	.57
Agreeableness	-0.167	-0.07	.948	-.01	-.31	.29	0.586	0.32	.750	.05	-.26	.35
Conscientiousness	-4.206	-2.07	.045	-.30	-.56	-.00	-4.715	-3.19	.003	-.44	-.66	-.16
Neuroticism	-0.085	-0.06	.954	-.01	-.31	.30	-0.374	-0.35	.730	-.05	-.35	.25
Openness	7.382	3.67	.001	.49	.22	.69	6.931	4.74	.000	.59	.35	.76
Model 2: Demographics												
Extraversion	-0.429	-0.32	.749	-.05	-.37	.27	2.064	1.84	.074	.28	-.04	.55
Agreeableness	1.070	0.59	.560	.10	-.23	.40	1.187	0.76	.454	.12	-.21	.43
Conscientiousness	1.174	0.70	.489	.11	-.21	.42	-1.650	-1.16	.254	-.18	-.48	.14
Neuroticism	-0.653	-0.54	.590	-.09	-.40	.24	-0.740	-0.72	.479	-.12	-.42	.21
Openness	3.286	2.18	.036	.33	.01	.59	5.088	4.02	.000	.55	.27	.74
Spatial lag	0.844	6.52	.000	.73	.53	.85	0.752	4.45	.000	.59	.33	.76
GDP per capita (log)	14.358	2.38	.022	.36	.05	.61	6.219	1.10	.277	.18	-.15	.47
Population density (log)	0.182	0.17	.865	.03	-.29	.34	-0.116	-0.12	.902	-.02	-.34	.30
Non-White population (%)	0.061	0.75	.459	.12	-.21	.42	0.028	0.39	.702	.06	-.26	.38
Model 3: Politics/Religiosity												
Extraversion	-0.334	-0.27	.785	-.05	-.37	.29	1.909	2.37	.023	.37	.04	.61
Agreeableness	-0.282	-0.15	.880	-.03	-.35	.31	-1.171	-0.95	.350	-.16	-.46	.18
Conscientiousness	1.786	1.14	.260	.19	-.15	.49	-0.148	-0.14	.887	-.02	-.35	.31
Neuroticism	0.129	0.11	.913	.02	-.31	.34	0.088	0.11	.911	.02	-.31	.35
Openness	1.025	0.66	.513	.11	-.23	.42	1.686	1.62	.115	.26	-.07	.54
Spatial lag	0.591	4.02	.000	.56	.28	.75	0.327	2.21	.034	.35	.02	.60
GDP per capita (log)	8.044	1.36	.184	.22	-.12	.51	1.893	0.47	.644	.08	-.26	.40
Population density (log)	-0.177	-0.18	.859	-.03	-.36	.30	-0.479	-0.71	.482	-.12	-.43	.22
Non-White population (%)	-0.008	-0.08	.934	-.01	-.34	.32	-0.126	-1.84	.073	-.29	-.57	.04
Trump 2020 vote (%)	-0.428	-2.25	.031	-.35	-.61	-.03	-0.652	-5.21	.000	-.66	-.81	-.42
Highly religious adults (%)	-0.055	-0.33	.744	-.05	-.38	.28	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 percent of people who received at least one dose of a two-dose COVID-19 vaccine as of December 28, 2021.

Figure 2. Statewide percentage of people who were fully vaccinated against COVID-19 as of December 28, 2021.

Figure 4. Bivariate correlation (with OLS best-fit line and 95% CI) between state-level openness to experience and percent of people receiving at least one dose of a two-dose COVID-19 vaccine as of December 28, 2021.

Figure 5. Bivariate correlation (with OLS 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.