Political partisanship and reading and math scores predict vaccination rate differences in U.S. states *

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Abstract

Background. Americans have responded differently to the Covid-19 pandemic as a function of which state they live in. In 2020, mask wearing percentages and restrictions on public behavior were typically higher in New England states and lower in the upper-Midwest states. In 2021, vaccine hesitancy and vaccination rates repeated this pattern. Psychological research suggests that the state differences are in part due to geographical differences in cognition, Big 5 personality factors, and ideology. The research in this report tests this inference. **Methods.** Multiple regression models tested whether aggregated, state-level differences in personality and cognition predicted state-level differences in vaccine hesitancy and vaccination rates. The covariates included political orientation, urbanization, income, and education. **Results.** The partisan makeup of state legislatures (e.g., percentage of Democrats) and state-aggregated reading comprehension and math scores accounted for 62% of the between-state variance in vaccine hesitancy and 82% of the variance in between-state vaccination rates. **Conclusions.** The results are consistent with the observation that in the United States, the response to Covid-19 depends largely on psychological and political factors that were in place prior to the pandemic. This suggests that institutions with societal responsibilities will have to resort to incentives and mandates to ensure sufficiently high vaccination rates. The results are also relevant to (1) studies of the geographical distribution of individual psychological differences and their possible impact on societal level differences, such as health disparities, and (2) new research on the impact of Covid-19 on cognition.

Introduction

Covid-19 vaccination rates vary widely across the U.S. states. On August 1, 2021, more than three months after the Biden administration and the Centers for Disease Control and Protection (CDC) announced that all adults were eligible to get a Covid-19 vaccination, state vaccination rates ranged from 34 to 66%, with no states reaching the 70% target [1]. Three months later (October 28), the rates ranged from 43 to 74%, with just four states exceeding 70%. This pattern repeats events of 2020. In the states that now show large differences in vaccination rates, there were large differences in mask wearing rates and policies regarding public behavior [2, and see Table S1]. Although it has become a familiar story, the persistence of state differences in response to the Covid-19 pandemic is surprising. Vaccinations promise to turn back the pandemic, not just stop its spread [3], they are less onerous than mask wearing, and, has been widely publicized, the likelihood of dying of Covid-19 is more than ten times higher for the unvaccinated [4]. Vaccinations, as is widely agreed, provide the most efficient means to a return to some semblance of pre-pandemic normalcy, but in the U.S., state differences stand in the way of sufficiently high vaccination levels. My goal in this report is to identify predictors of state-level vaccination rate differences.

A common theme in accounts of state differences in the response to Covid-19 is that states with Republican governors, particularly those outside of New England, have lower rates of mask wearing and now lower vaccination rates [5, 6; Table S1]. Less well known is that personality differences, as measured by the Big 5 questionnaire, also predict differences in the response to Covid-19 [7]. For instance, *Openness* predicted mask wearing in a study that included controls for partisan political preferences, urbanization, education, and income, whereas *Conscientiousness* predicted differences in state policies (8). These finding, and others like them [7], suggest that aggregated individual characteristics might also predict vaccine hesitancy and vaccination rates.

The literature on individual correlates of health predicts that differences in cognition and Big-5 personality traits are likely predictors of differences in vaccination rates. Researchers consistently find

that individuals who score higher on verbal, quantitative, and abstract reasoning tests have lower overall morbidity and mortality rates [9, 10]. The differences are large and persist after controlling for social-economic status. In light of these results, a team of United Kingdom researchers tested whether performance on a series of cognitive tests (taken pre-pandemic) predicted differences in the hesitancy to get a newly announced, successful Covid-19 vaccine [11]. They found that those who scored in the bottom decile of the cognitive tests were more than twice as likely to say they would not get vaccinated, despite the positive safety and efficacy findings of the new vaccine. However, the study did not include controls for political orientation, which is the factor that has dominated the response to Covid-19 at both the individual and state level in the United States [12-15]. Thus, whether differences in cognitive performance predict differences in Covid-19 vaccination rates in the U.S. is not certain.

The relations between the Big 5 personality factors and the response to Covid-19 are complex. Pre-covid-19 research shows that individuals who score high on *Conscientiousness* tend to have better health habits [16]. However, in the U.S., *Conscientiousness* is also highly correlated with voting for Republican candidates, and individuals who identify as Republicans are more likely to reject the CDC health recommendations in regard to Covid [13 -15]. Consequently the correlations between the Big-5 personality factors and the response to Covid-19 have been at odds with pre-Covid-19 results, and, perhaps because of this, inconsistent and weak [17, 18]. In addition, there is the complication that individual level results do not necessarily predict state level results, and *vice versa*—the much discussed "ecological and individual fallacies" [19, 20]. Thus, it is unclear as to whether personality factors will predict vaccine hesitancy and vaccination rates.

In sum: previous research suggests that cognitive, personality, and political differences provide a reasonable starting point for identifying the strongest predictors of differences in the likelihood to get vaccinated against the coronavirus. However, the relevant research has been carried out with individuals, whereas the goal of this report is to explain state-level differences. To this end, the predictors in this report include state-level factors (e.g., the 2020 state policies on mask wearing) and state-level, aggregated individual differences (e.g., Big 5 personality factors and reading comprehension scores). This

approach follows in the tradition of recent studies of geographical psychology [21]. For instance, state-level aggregated individual differences in personality and cognition predicted state-level presidential voting patterns and various measures of good health [22, 23]. This report tests whether the same holds for vaccine hesitancy and vaccination rate.

Materials and Methods

Journal articles, Centers for Disease Control and Prevention (CDC), the U.S. Census Bureau, and university and private research organizations provided the data for this report. The units of analysis are the 50 U.S. states. The data are publicly available and de-identified; their use is exempted from review by the Boston College Institutional Review Board.

Vaccination Rates & Estimated Vaccine Hesitancy

Vaccination rate and vaccine hesitancy are the dependent measures. Vaccination rate is the percentage of residents in each state that have received both doses of a two-dose protocol or a single dose of a one-dose protocol. The CDC lists these percentages daily [1].

The Office of the Assistant Secretary for Planning and Evaluation of the Department of Health and Human Services [ASPE, 24] developed state, county, and sub-state level predictions of hesitancy rates. Their analyses are based on the Census Bureau's nation-wide Household Pulse Survey [25]. From May 25 to June 7, 2021, the Census Bureau asked survey participants if they would get a vaccine once one was available. There were five possible responses: definitely get a vaccine, probably get a vaccine, unsure, probably not get a vaccine, and definitely not get a vaccine. On the basis of demographic and other data, ASPE analysts turned the survey responses into estimated state and county vaccine hesitancy rates. The sum of the last three responses (unsure, probably not, and definitely not) is this report's measure state-level vaccine hesitancy.

Political Partisanship

There are several possible measures of political orientation: the percentage of votes for Democratic and Republican presidential candidates, the political party of the state governor, and the partisan makeup

of state legislatures. The partisan makeup of the state legislatures promised to provide the most representative measure of the political views of a state's residents. In 2019, the average number of elected state legislators was 148, each one represented a geographic locality, and the localities account for every geographic region in a state. The National Conference on State Legislatures [26] provided the number of Democratic and Republican office holders for each state.

Stringency

Oxford University's COVID-19 Government Response Tracker research team created the state stringency rankings for the 50 US states [27]. Four indictors made up the stringency scale: (1) a containment and health index, which combines restrictions and closures with health measures, such as testing policy and contact tracing, (2) economic policies, such as the level of funding for recently unemployed workers, and (3) a stringency index, which records the strictness of the policies that restrict public behavior, and (4) an index that tracts the overall government approach to lockdown policies. The research team translated the four indices into an additive "stringency" scale of 1 to 100. The scale used in the present report reflects data collected from late August to early December of 2020.

Cognition

McDaniel [28] provided the state-level cognitive performance measures. His data set is based on the National Assessment of Educational Progress's [29] Grade 4 and Grade 8 standardized tests for reading comprehension and mathematical reasoning. NAEP administers these tests to a sample of public school children in each of the fifty states. The scores in McDaniel's tables are four-year averages from tests that were administered between the years 1990 to 2005. McDaniel and others [30] refer to the results as "IQ" scores. In support of this usage, McDaniel points out that the NAEP test is very much like tests that correlate strongly with nominal IQ tests. However, given that the NAEP refers to their tests as "report cards," and IQ tests typically sample a wider range of cognitive abilities than do the NAEP tests [31], "elementary school academic proficiency" seemed the more appropriate descriptor. However, regardless of label, the NAEP test scores predict a wide range of important state-level results, including various health disparities [22, 28, 30]. Year to year reliability of the NAEP scores was quite high, with an alpha

of 0.99 for both mathematics and reading. For convenience, I refer to the NAEP test scores as "cognitive proficiency".

Urbanization

Previous accounts of differences in the response to Covid-19 have emphasized rural/urban differences [15]. The regression analyses include urbanization as defined by the U.S. Census Bureau as a potential predictor and control for cognition and partisan ideology. The Census Bureau's definition is based on the percentage of the state population that live in urban areas. The state data were downloaded from Iowa State University Community Indicator website [32].

Personality

Rentfrow, Gosling and Potter's 2008 summary of a nation-wide, 44 question Big-5 personality survey [33] provided the data. The survey recruited 619,397 participants and was carried out between December 1999 and January 2005. The researchers aggregated the results by state and then ranked each state on each of the Big 5 personality dimensions. The percentage of respondents from each state was proportional to the state's population (r = 0.98), and the race and ethnicity of the participants were roughly proportional to their statewide counterparts. The average inter-item alpha reliabilities for individuals averaged 0.81, and for states they averaged 0.89. The test-retest state-level scores were similar, with correlation coefficients that ranged from 0.77 to 0.88. For *Openness* and *Conscientiousness*, the factors that are most strongly correlated with political preferences, state Covid-19 policies and mask wearing, the test-retest correlations were both 0.88. The factor structure for the aggregated state data matched that of individuals, selected independently of residence.

Income

To estimate the influence of income, I used the average median household income for the years 2017 to 2019. The Census Bureau's "Historical Income Tables" [34] provided the data.

Education

The index for state differences in education level was the U.S. Census Bureau's [35] estimate of the percentage of residents in each state who earned a college degree or higher by age 25. The survey is a five-year estimate for the years 2013 to 2017.

Percent of State Population Not Born In-State

U.S. relocation patterns reflect personality characteristics [36] and are correlated with state-level differences in the response to Covid-19 [8]. The Census Bureau [37] tracks the percentage of such births in their "State of Residence by State of Birth" tables. I used the tables for 2019.

Mask wearing

State mask wearing percentages are not a focus of this report, but are included (Table S1) as evidence for the reliability of the state differences which are the focus of this paper (vaccine hesitancy and vaccination rates). The data were collected in June of 2020 at the county level [2]. The survey asked: "How often do you wear a mask in public when you expect to be within six feet of another person?" Approximately 250,000 individuals responded. To obtain state-level results, I weighted the survey's findings by the county's share of the state population and then summed across counties. (See the Excel data file in supplementary material.)

Statistical Analyses

Multiple linear regression methods quantified the relationships between the predictors, vaccine hesitancy, and vaccination rates. To keep the ratio of observations to predictors above the recommended ten-to-one ratio, the primary analyses limited the number of predictors to four. This was arranged by using Stata's *tryem* command, which compared every possible subset of four predictors. In addition, to ensure that *tryem's* selections were robust (remained stable), I evaluated how much the beta weights changed when they were included in regressions which included more than four predictors.

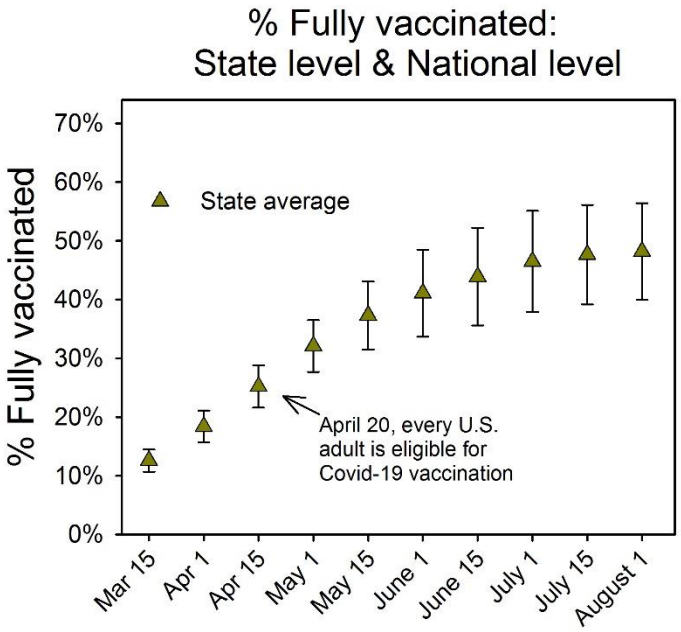

Fig. 1. The percentage of fully vaccinated Americans from March 15 to August 1, 2021, as determined by state averages.

Results

Fig. 1 summarizes the cumulative, bi-weekly, state vaccination rates from March 1 of 2021 to August 1 of 2021. The triangles show the average number of individuals in each state (n = 50) who were fully vaccinated on the date given by the x-axis. The start date is approximately one month prior to President Biden's request that the states expand vaccine eligibility to all adults; the end date marks a period in which vaccination rates were representative of the just previous month and the following two months. From March 15 to May 15, the percentage of those fully vaccinated increased by about 6 to 7% every two weeks, but, then, just as the vaccines became more available, the increments decreased, reaching a low of about 1% every two weeks. This pattern of changes is virtually the same for the average individual, regardless of state of residence (see Fig. S1 for a comparison).

Insert Table 1 about here

Table 1 lists the bivariate correlations. The entries include the percentage of those fully vaccinated on the first of the month in June, July, and August of 2021, the percentage of those who were vaccine hesitant according to questionnaires completed during the last week of May and the first week of June 2021, the personality variables that were most strongly linked to mask wearing and state policy [8], cognitive proficiency, and factors that figured prominently in previous accounts of the response to Covid-19: educational attainment, urbanization, and income. The vaccination rates are highly correlated with one another (r = 0.98 to 0.99), and the correlations between vaccination rates and the other variables are often quite high. Taking August 1 as an example, its top five correlates were: hesitancy (r = -0.84), partisan makeup of the state legislature (r = 0.77), the stringency of state restrictions on public behavior during the last quarter of 2020 (r = 0.67), Big 5 *Openness* (r = 0.47), and cognitive proficiency (r = 0.44). In contrast, *Agreeableness*, *Extraversion*, and *Neuroticism* (the other Big 5 personality factors) were weakly correlated with vaccination rates (not shown). Given the high correlations among the vaccination rates, the correlations for August 1 vaccination rates were similar to those for the June 1 and July 1. That is, the August 1 vaccination rates provide a representative portrait of U.S. state vaccination rates for the summer of 2021. Table S2 lists the means, medians, and standard deviations of the Table 1 measures.

Insert Tables 2a and 2b about here

Tables 2a and 2b list the multiple regression results. The goals were to determine the relative strength of the predictors and identify which ones continued to be significantly correlated with hesitancy and vaccination rates when combined with other predictors. As noted in the *Methods* section, Stata's *tryem* routine selected the four predictors that explained the most variance. In agreement with the assumptions for multiple regression, the two dependent measures met various criteria for normality (Shapiro-Wilks, skewness and kurtosis).

The partisan makeup of the state legislative bodies, cognitive proficiency, urbanization and the percentage of residents born out of state accounted for 65% of the between state differences in vaccine

hesitancy. The beta weights for all but "born-out-of-state" were significant at the 0.05 level, and, together, state political partisanship and cognition accounted for accounted for 62% of the variance (which is to say, 95% of the explained variance). The variance inflation factor values are well within the acceptable range for concerns regarding collinearity [e.g., 38]. Analogously, the test for heteroscedasticity indicates that the residuals were approximately constant across the range of predicted values, as is assumed.

The percentage of Democrats in state legislatures, cognitive proficiency, vaccine hesitancy, and the stringency of Covid-19 restrictions on public behavior accounted for 87% of the state differences in vaccination percentages. All four beta weights were statistically significant at the 0.05 level, and, together, political partisanship and cognition accounted for 82% of the variance in vaccination rates (94% of the explained variance). Although hesitancy was the strongest correlate of vaccination rates (r = -0.84), political partisanship and cognitive proficiency accounted for most of the variance in vaccination rates. As with hesitancy, the diagnostic statistics indicated that the basic assumptions of multiple regression were met.

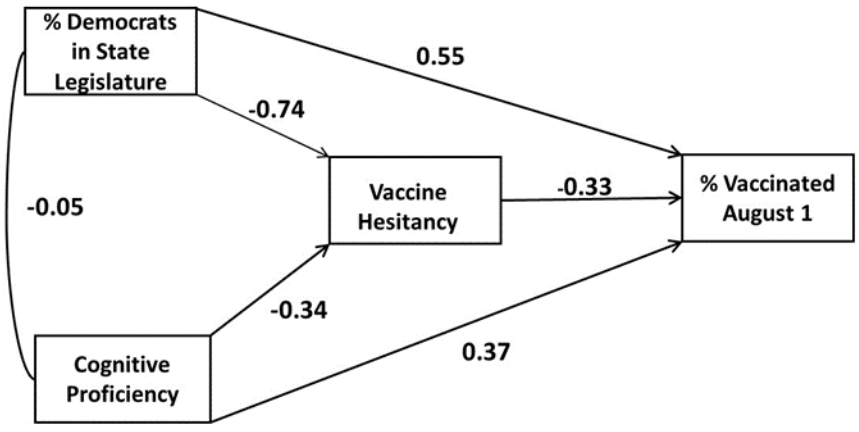

Fig. 2. Path model of the associations between the partisan makeup of the state legislature, state-level cognition, state-level vaccine hesitancy rates, and state vaccination rates.

Figure 2 provides a path model summary and synthesis of the multiple regression results. It tests whether vaccine hesitancy functioned as a mediator of the associations between the two exogenous variables (political preferences and cognition) and vaccination rates. Hesitancy was a statistically significant mediator (see Tables 3a and 3b). However, its contribution, apart from its association with partisanship and cognition, was small. It added only about 4% to the explained variance, and, accordingly, the direct effects of partisanship and cognition were much stronger than the indirect, hesitancy-mediated effects. For example the direct to indirect path coefficient ratios were 2.33:1 for partisanship and 3.36:1 for cognition.

Insert Tables 3a and 3b about h ere

The path-coefficient predictions tell a similar story (see Table 3a). The model predicts that a one standard deviation increase in the percentage of Democratic seats in the state legislature will decrease vaccine hesitancy by 0.74 standard deviation units (4.29%) and increase the percentage of fully vaccinated state residents by 0.80 standard deviation units (e.g., 6.56%). Analogously, a one standard deviation increase in cognitive scores should yield a 0.34 standard deviation decrease in vaccine hesitancy (- 1.97%) and an 0.48 standard deviation increase in vaccination rates (3.94 %), *ceteris paribus*. (The calculations are based on the data in Table S2 and 3A.) The fit statistics (Table 3b) provide no concerns

regarding the reliability of the predictions.

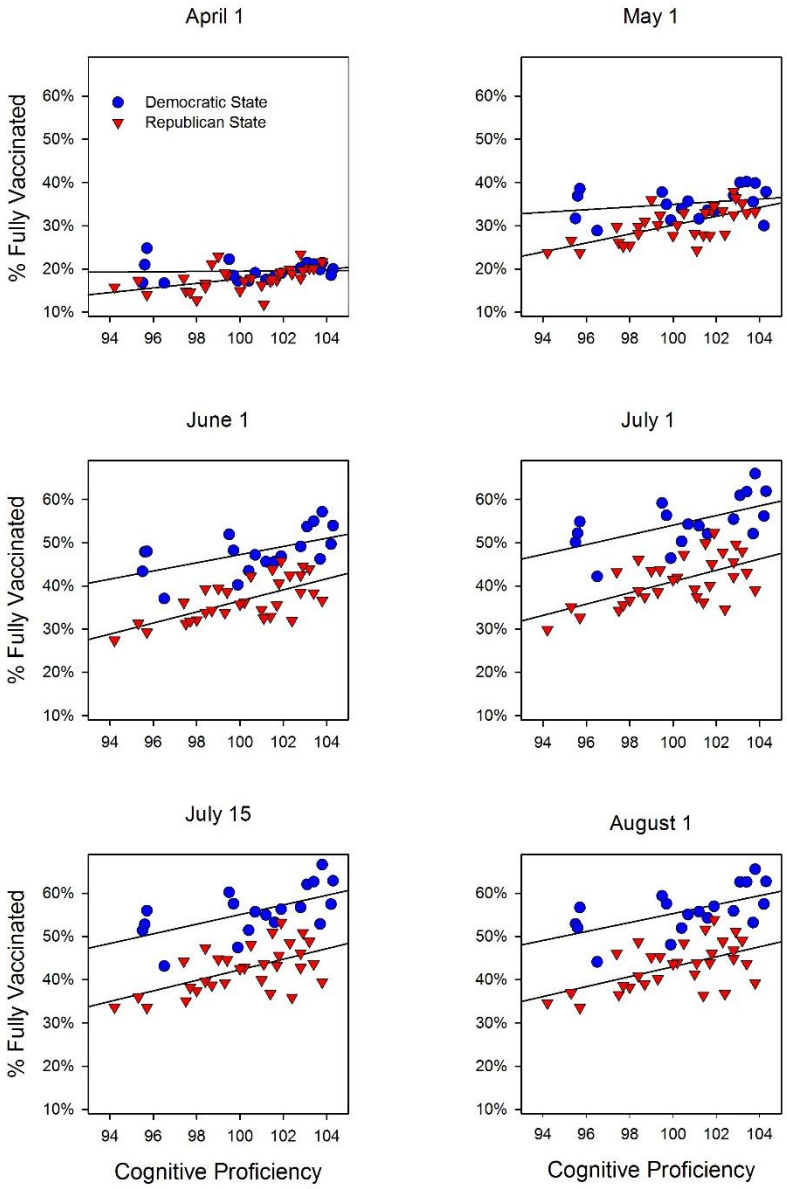

Fig 3. U.S. state vaccination rates as a function of cognitive proficiency and the state's dominant political party.

Figure 1 summarized vaccination rates from early March to August 1 of 2021, whereas the regression analyses are for a single day: August 1. Figure 3 shows the relations between the partisan makeup of state legislatures, cognitive proficiency, and percent vaccinated for six different time points from April 1 to August 1 of 2021. Two results are noteworthy. As coronavirus vaccines became more

available and more individuals got vaccinated, partisan political allegiances and cognitive performance made more of a difference. Second, the fitted lines are roughly parallel. This means that in the state-level analyses, political allegiances, and cognition did not interact.

Beta coefficients can change as a function of which predictors are included in the regression model. Tables 2a and 2b summarized the multiple regression analyses which explained the most variance when the number of predictors was limited to four. I tested whether the beta coefficients were stable by redoing the analyses with all the possible predictors from Table 1. There were six additional predictors for vaccination rates and five for hesitancy. The number of predictors did not alter the significance level of the four strongest predictors of vaccination rates, two beta scores slightly increased, two slightly decreased, their rank order remained the same, and the average absolute change in the beta weights was 0.03. This same exercise for vaccine hesitancy left the rank order of the beta weights for the top four predictors intact, rendered urbanization no longer statistically significant, and resulted in an average absolute change in the beta weights of 0.065. Thus, large changes in the regression environment produced no change in the rank order of the beta weights, little change in significance levels, little change in the absolute magnitudes of the beta weights for vaccination rates, and moderate changes in the magnitudes of the beta weight for hesitancy.

Discussion

States differ in how they responded to the Covid-19 pandemic. These differences have had and will continue to have profound consequences for their residents. States with low vaccination rates have high Covid-19 case rates and death rates [39-41]. My goal was to identify the factors that predicted state differences in vaccination rates and, in particular, to test whether established geographic variation in psychological measures helped explain variation in vaccine hesitancy and vaccination rates. Democratic seats in the state legislatures and state-level aggregated reading comprehension and math reasoning scores accounted for about 82% of the variance in vaccination rates and 62% of the variance in vaccine hesitancy. Hesitancy provided some additional explained variance in vaccination rates (4.2%), but as

shown in the path model, its influence depended largely on its association with political partisanship and cognition. Thus, the analysis successfully identified two predictors that accounted for much of the variation in state vaccination rates.

The "ecological fallacy" [19] refers to the assumption that differences between groups necessarily apply to differences between the individuals who compose the groups. However, as has been repeatedly pointed out, results for aggregated data do not necessarily hold for individuals that compose the aggregates [20, 42]. For example, in state level analyses, *Conscientiousness* tends to be positively correlated with smoking rates and/or the likelihood of quitting smoking, whereas in individual-level analyses, these correlations tend to be negative [43-44]. This is not contradictory, but the expected results if within each state, conscientiousness is negatively correlated with quitting smoking, but the baseline level of smoking is higher in states that rank high in *Conscientiousness* [see 8 for a numerical example].

However, the state level correlations summarized in the tables and graphs replicated well-established individual results. As in the present report, individual-level research shows strong correlations between (1) childhood cognitive performance and adult health [9], between (2) adult cognitive performance and vaccine hesitancy [11], and between (3) political orientation and vaccine hesitancy [12, 13]. What this study adds to these results is the association between cognition and vaccination rates (not just hesitancy), quantification of the variables of interest, and the inclusion of controls for partisan politics. No previous study controlled for political factors while evaluating the relationship between cognition and health. However, some qualifications and limitations are in order.

Several researchers have reported that college graduates are more likely to be vaccinated than those without a college degree [15, 45]. Table 1 reveals a positive correlation between education and vaccination, but it is small and not statistically significant. Possibly the education effect varies from state to state [see 45 for Florida], or education is a case in which the state aggregated data failed to faithfully reflect individual-level results.

Although the variance accounted for percentages were quite high by the standards of social science research, the account presented here is far from complete. A minimum of 15 years separated the cognitive

scores from the onset of the Covid-19 pandemic, and there is also much "distance" between the state legislatures and getting vaccinated. For the cognitive scores, research indicates that the links joining test scores with vaccinations likely included differences in educational attainment, occupational status, income, and differences in heath related behavior [30, 31]. Put more generally, lifestyle and identity likely pave the way from elementary school reading and reasoning tests to getting vaccinated against Covid-19. For politics, research indicates that the links joining the partisan makeup of the state legislatures to vaccination likely included the degree of trust in the government, degree of support for Donald Trump, degree of urbanization, degree of trust in science, favored sources of information regarding the pandemic, and differential tendencies to believe the media and the endorse the idea that Democrats had conspired to exaggerate the Covid-19 threat [46-48]. Taking into consideration the factors that inform these limitations would enrich the account presented here; however, there is no reason to believe it would fundamentally alter it. Also, note that if individual-level analyses do not take into account the state-level correlations described in this report, the state effects will increase the errors terms, possibly distorting the findings.

The results are also relevant to recent concerns regarding the neurological sequelae of Covid-19 infections. A review of the pre-Covid-19 coronavirus literature indicates that we should expect current corona variants to produce cognitive deficits in some victims, particularly those with more serious symptoms [48]. As predicted, recent research reports that a substantial fraction of Covid-19 patients experience cognitive deficits even though they no longer show acute respiratory symptoms [49, 50]. However, these were relatively small studies, and, as the authors point out, they were not longitudinal. Thus, it is possible that to some degree the cognitive symptoms of "long-haul" Covid-19 reflect the pre-existing negative correlation between cognitive proficiency and health [10] and/or cognitive-based differential susceptibility to the cognitive features of long-haul Covid-19.

My goal was to identify the major predictors of U.S. state differences in vaccination rates. Personality was not a meaningful predictor but cognition was. These results are consistent with the more general point that whether or not one gets vaccinated is in large measure a function of factors that preceded the epidemic. This dynamic sets in motion a serious challenge for politically polarized societies,

such as the U.S. Given that general beliefs about the world are so tied to politics in politically polarized countries, persuading the unvaccinated to get vaccinated is a hard sell if it comes from the "other side." Thus, to move the U.S. (and likely many other highly polarized countries) to some semblance of pre-pandemic normalcy, institutions with societal responsibilities must resort to incentives and mandates. This inference has much support [51, 52]. A second implication of the data presented here, but one which has received little attention, is that current government officials should weaken the ties between their political party and health services. This would greatly enhance the chances of a more effective response to the next pandemic.

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Table 1: The bivariate correlations

	Fully Vacc June 1	Fully Vacc July 1	Fully Vacc August 1	Vacc Hesitancy	% Demo-crats in State Legislature	Stringency of State Restrictions	Cognitive Proficiency	% College Graduates	Urban-ization	% Born Out of State	State Adj Personal Income	Big 5 Conscien-tiousness	Big 5 Openness
Fully Vacc June 1	1.0												
Fully Vacc July 1	0.99***	1.0											
Fully Vacc Aug 1	0.98***	0.99***	1.0										
Vacc Hesitancy	-0.82***	-0.83***	-0.84***	1.0									
% Dems in State Legis-lature	0.75***	0.78***	0.77***	-0.72***	1.0								
Stringency of State Restrictions	0.66***	0.68***	0.67***	-0.54***	0.78***	1.0							
Cognitive Proficiency	0.49***	0.46***	0.44**	-0.30*	-0.05	-0.01	1.0						
% College Graduates	0.10	0.11	0.15	-0.10	0.09	0.10	0.06	1.0					
Urbanization	0.21	0.26	0.26	-0.44**	0.48***	0.28	-0.16	0.21	1.0				
% Born Out of State	0.19	0.24	0.24	-0.13	0.30*	0.18	-0.01	0.24	0.30*	1.0			
State Adj Personal Income	0.42**	0.39**	0.38*	-0.38*	0.10	0.12	0.60***	0.13	0.23	0.03	1.0		
Big 5 Conscien-tiousness	-0.49***	-0.45**	-0.40**	0.29*	-0.43**	-0.49***	-0.22	-0.11	0.04	-0.14	-0.35**	1.0	
Big 5 Openness	0.36*	0.43**	0.47**	-0.46**	0.49***	0.39*	0.06	0.28*	0.39**	0.37*	0.13	-0.09	1.0

* <= 0.05

** <= 0.005

*** <= 0.0005

Table 2a: Strongest four predictors of vaccination hesitancy (May 26 – June 7, 2021)

Dependent Variable: State level vaccination hesitancy	Coefficient	Std. Error	t	P > |t|	Beta
% Democrats in State Legislature	-0.203	0.030	-6.86	0.000	-0.67
Cognitive Proficiency	-0.008	0.002	-4.32	0.000	-0.37
Urbanization	-0.085	0.039	-2.17	0.035	-0.22
Born out of State	0.0007	0.0005	1.44	0.155	0.13
Constant	1.10	0.191	5.75	0.000	
N = 50, R^2 = 0.68, Adjusted R^2 = 0.65, F(4, 45) = 23.58, Prob > F = 0.000 heteroscedasticity test: X^2 = 3.03, p = 0.08 VIF = 1.22 (1.03 – 1.39)					

Table 2b: Strongest four predictors of state-level vaccination rates (August 1, 2021)

Dependent Variable: Percent of state residents fully vaccinated	Coefficient	Std. Error	t	P > |t|	Beta
% Democrats in State Legislature	17.47	4.62	3.78	0.000	0.41
Cognitive Proficiency	1.09	0.18	5.97	0.000	0.36
Vaccine Hesitancy	-48.19	12.30	-3.92	0.000	-0.34
Stringency of State Restrictions	0.10	0.05	2.06	0.045	0.17
Constant	-64.33	20.32	-3.17	0.003	
N = 50, R^2 = 0.88, adj R^2 = 0.87, F(4, 45) = 79.94, Prob > F = 0.000 heteroscedasticity test: X^2 = 0.39, p = 0.53 VIF = 2.73 (1.33 – 4.29)					

Table 3a: Standardized coefficients for path model of hesitancy mediated vaccination rates.

Dependent Variable	Predictor	Direct Effect	Indirect Effect (via Hesitancy)	Total Effect
Hesitancy (mediator)	% Democrats in State Legislature	-0.74***	---	
	Cognitive Proficiency	-0.34***	---	
% Vaccinated	% Democrats in State Legislature	0.56***	0.24***	0.80***
	Cognitive Proficiency	0.37***	0.11**	0.48***
	Hesitancy	-0.33***	---	-0.33***

** =< 0.005
*** = < 0.0005

Table 3b: Path Analyses Fit Statistics

Predicted Variable	*RMSEA, p <= 0.05*	*AIC/BIC*	*CFI*	TLI	*SRMR*
% Vaccinated	1.0	301.9/328.7	1.000	1.000	0.000
Root Mean Square Error of Approximation, Akaike's & Bayesian Information Criteria, Comparative Fit Index, Tucker Lewis Index, Standardized Root Mean Square Residual					

Table S1 shows that states in which residents were more likely to wear masks in 2020 are states with higher vaccination rates in 2021/

Table S1: State-level mask wearing and vaccination correlations.

	Fully Vacc June 1	Fully Vacc July 1	Fully Vacc August 1	% State Population Who Wore Mask
Fully Vacc Aug 1, 2021	1.0			
Fully Vac July 1, 2021	0.99***	1.0		
Fully Vac August 1, 2021	0.98***	0.99***	1.0	
% State Population Who Wore Mask, July 2 – July 14, 2020	0.55***	0.62***	0.64***	1.0

*** <= 0.0005

Figure S1. State average and national average vaccination rates. The national averages is based on all of the United States, regardless of residence. The two averages are virtually identical.

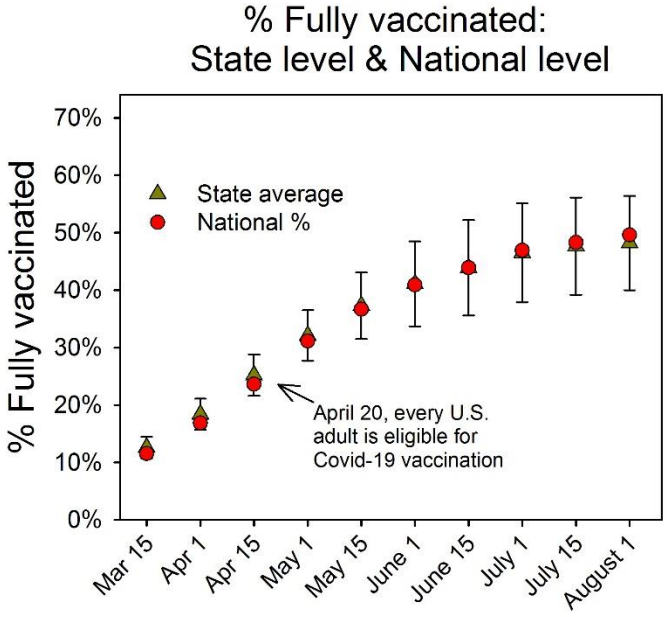

Table S2: Averages, Medians, and standard deviations of the key measures

		Average	Median	Standard Deviation	
Fully Vaccinated June 1		41.0%	40.4%	7.4%	
Fully Vaccinated July 1		46.3%	45.8%	8.7%	
Fully Vaccinated August 1		48.1%	47.4	8.2%	
Vaccine Hesitancy		16.6%	16.5%	5.8%	
% Democrats in State Legislatures		46.7%	43.5%	19.3%	
Stringency of State Restrictions (rank)		25.7	25.5	14.9	
Cognitive Proficiency		100.3	100.9	2.7	
% College Graduates		30.1%	29.5%	5.1%	
Urbanization		73.7%	73.8	14.8%	
% Born Out of State		42.7%	40.9%	11.4%	
State Adjusted Personal Income		$56,009	$54,994	$5707	
Big 5 Conscien-tiousness (rank)		26.3	26.5	14.9	
Big 5 Openness (rank)		25.5	25.5	14.6	