The influence of social norms varies with “others” groups:

Evidence from COVID-19 vaccination intentions

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Abstract

The theory that health behaviors spread through social groups implies that efforts to control COVID-19 through vaccination will succeed if people believe that others in their groups are getting vaccinated. But “others” can refer to many groups, including one’s family, neighbors, fellow city or state dwellers, or co-partisans. One challenge to examining these understudied distinctions is that many factors may confound observed relationships between perceived social norms (what people believe others do) and intended behaviors (what people themselves will do), as there are plausible common causes for both. We address these issues using survey data collected in the US during late fall 2020 ($N = 824$) and spring 2021 ($N = 996$) and a matched design that approximates pair-randomized experiments. We find a strong relationship between perceived vaccination social norms and vaccination intentions when controlling for real risk factors (e.g., age) as well as dimensions known to predict COVID-19 preventive behaviors (e.g., trust in scientists). The strength of the relationship declines as the queried social group grows larger and more heterogeneous. The relationship for co-partisans is second in magnitude to that of family and friends among Republicans but undetectable for Democrats. Sensitivity analysis shows that these relationships could be explained away only by an unmeasured variable with large effects (odds ratios between 2 and 15) on social norms perceptions and vaccination intentions. And a prediction from the “false consensus” view that intentions cause perceived social norms is not supported. We discuss the implications for public health policy and understanding social norms.

Significance statement

Willingness to engage in COVID-related preventive behaviors including vaccination depends on the perceived extent to which others engage in them. But “others” can refer to groups of varying size, heterogeneity, and personal relevance. We find the strongest relationships between vaccination intentions and social norms for respondents’ friends and family—and among

Republicans, co-partisans—and these relationships weaken as the reference group expands to people in one’s neighborhood, city, and state. We see this pattern in two US studies even in pairs of respondents identical in political party, gender, and race and highly similar on numerous possible confounds (e.g., age, ideology, trust in science). Public health efforts to increase vaccine uptake should seek ways to leverage social norms among close ties.

Introduction

Beliefs about others' behavior—perceived social norms—influence people's own actions and intentions (1-4).¹ The idea that social norms drive health behaviors has guided research in public health generally (7-9) and on vaccination specifically (10, 11). Studies from COVID-19 find that people are more likely to vaccinate (12-14), wash their hands (15, 16), wear masks (17), stay at home (16), and social distance (15, 17-22) the more they believe that other people engage in these preventive behaviors.

While the idea that what others do affects our own behaviors is well established, there is less consensus about exactly who such others are (23). People belong to many partially overlapping groups that vary in size, homogeneity, and relevance (Figure 1; see (24) for a similar conception) and thus likely think about these groups differently. Yet a close read of COVID-19 social norms studies shows that “others” can refer to numerous different groups, from family and friends (15, 17, 19, 21) or close social ties (20, 22) to neighbors (14, 25), people in one's community (19), fellow survey respondents (11), people in one's country (12, 16, 18), people in general (13), or all of humankind (22). Ignoring this distinction has implications for social norms research—studies ostensibly on the same effect may be measuring very different instantiations—as well as for public health strategies hoping to harness the evident strength of social norms through messaging or other interventions.

We examine this issue in two studies comparing people's own vaccination intentions with their perceptions of others' intentions. Study 1 measured these perceptions among four groups of others: family and friends; neighbors; city residents; and state residents. Study 2 replicates the first and adds perceptions of vaccination intentions among co- and out-partisans, a dimension that to

¹ Social norms are commonly divided into injunctive norms (what people think is right to do) and descriptive norms (what people in fact do) (5). Here we focus on the latter to avoid introducing a moral dimension (6) that further complicates an already complex problem space. All references to social norms in our studies refer to descriptive norms.

our knowledge has not been explored previously. We created homogeneous matched pairs to account for the fact that people in the same groups have many common characteristics that can explain away apparent social norm effects. For instance, an older adult may count more older than younger adults among her friends. If she does, then her greater likelihood of vaccination could be due to higher risk of poor COVID-19 outcomes (26) rather than beliefs about what her friends (who are also higher risk) plan to do. Similarly, Democrats are likely to report higher vaccination intentions (27) and may perceive greater intentions among family and friends because they *know* more Democrats (28, 29). In both cases, people's beliefs about others' intentions and their own intentions have a common cause, rather than the beliefs causing the intentions. The pair-matched research design allows us control for all of these confounds by comparing, say, two Democratic women who are within a few years of the same age and then asking whether the member of the pair who believes that more members of her family and friends group will get vaccinated also has higher intentions to be vaccinated herself.

We find that social norms perceptions predict vaccination intentions above and beyond numerous measured and plausible confounding influences, and that the strength of the relationship between descriptive social norms and vaccination intentions declines as groups become larger and more heterogeneous. We also find that among Republicans, perceptions of co-partisans' intentions have the second strongest relationship with one's own intentions, trailing only family and friends. To address two related threats to these inferences, we report (a) a formal sensitivity analysis showing that some unobserved variable driving the results would need to generate extremely large effects to change the interpretation, and (b) an additional result inconsistent with the "false consensus" interpretation (30) whereby people's own intentions drive their social norm perceptions rather than the other way around. We then discuss implications for public health and policy.

The present studies

A hypothetical experimental approach to the common cause problem would isolate differences in social norm perceptions by placing respondents into pairs that are highly similar on potentially confounding dimensions and then randomly assigning one member of each pair to perceive that more others will get vaccinated. We build on the intuitions from this idealized “pair-randomized” scenario in creating our own non-randomized design since assigning perceptions to people would be difficult and would teach us more about the effects of assigning perceptions than about perceptions themselves. Study 1 placed 824 survey respondents into 412 matched pairs² created to be highly similar on characteristics that either constitute risk factors or that have demonstrably predicted COVID-19 health behaviors even though they are not associated with risk. Study 2 placed 996 respondents into 498 pairs, similarly matched. For known risk factors, pairs were required to be identical on gender (female, male [32]) and race (White, Black, Latino, other [32-34]) and highly similar on age (26), education (35), and family income (33, 36). For other dimensions associated with COVID-19 health behaviors, pairs were required to be identical on party ID (Democrat, Republican, other [27, 37]) and similar on political ideology (liberal–conservative [38]), trust in science (39, 40), trust in government (38), religiosity (42), COVID-19 knowledge (43), and subjective assessments of that knowledge (44). The ensuing matched designs are conceptually equivalent to analyses using stratification, a method long used in the study of health behaviors (45); see Rosenbaum (46) for an overview of current techniques.

Was this process successful? Hansen and Bowers (47) developed a single test of the null hypothesis of no differences between the members of a matched pair’s covariate values taken all

² We used a non-bipartite matching algorithm (31) to create the pairs. Details and code in <https://github.com/thepolicylab/COVID-VaccinesSocialNorms>.

together. The result of this omnibus test for Study 1 is $\chi^2(7) = 5.1, p = .65$; that is, the covariate-to-perceptions relationship in our non-randomized paired design is consistent with what we would see in a pair-randomized experiment. Within pairs, the person who perceives more positive vaccination social norms is no more or less likely to have higher values on any of the matching variables than the person who perceives that fewer people intend to be vaccinated in their social context. The omnibus test for Study 2 also indicated a design that compares favorably to a pair-randomized experiment, $\chi^2(9) = 2.6, p = 0.98$. Table 1 shows individual tests of the null hypothesis of no difference between higher and lower perceivers within pairs for all covariates. These tests produced no unadjusted p -value less than .13; after adjusting for multiple testing using the Holm method, all $p = 1$. See [Supplemental Materials S4](#) for details on the distribution of differences.

Results

For data and analysis code, see github.com/thepolicylab/COVID-VaccinesSocialNorms. We preregistered Study 1 (osf.io/fqvp3); Study 2 employs the same analysis strategy with the addition of perceived vaccination intentions among partisan groups. Deviations from the preregistration are explained in [Supplementary Materials S1](#).

Study 1

We regress respondents' reported intentions on their perceptions of social norms for each of the groups of interest, conditional on pair. This is conceptually equivalent to comparing the intentions of the higher to the lower perceiver within-pair and taking the average across all of the pair differences. Perceptions were recoded to run from 0 = *None* to 6 = *All* group members will definitely vaccinate. Vaccination intentions were coded 1–5 ($M = 3.76, SD_{\text{unadjusted}} = 1.31$). The coefficients in Figure 2 (left) represent average differences in vaccination intention associated

with a 1 unit difference in perceptions of others' intentions. Figure 2 (right) shows the strong relationships between perceptions and intentions: a difference of even one point in perceptions of family/friends' intentions produces, on average, a difference of .35 points in intentions which is roughly equal to $\frac{1}{4}$ standard deviation difference in the outcome.

The relationships decline in strength for perceptions of norms in larger and more heterogeneous groups, and we can easily reject the null of no average effect for all of them (all p values $< .001$, two-tailed). The vaccination intention difference related to a one-point difference between perceived social norms is .24 at the state level, .28 at the city level, .30 among neighbors, and .35 among family and friends. To interpret these coefficients, consider the difference of one scale point—the change, for instance, in believing that “About three quarters” as opposed to “About half” of one’s family and friends will get vaccinated. Given that the mean vaccination intention was 3.76 (between “Not sure” and “Maybe will”), even a one-point difference in perceived social norms can push intentions from this mean to “Maybe will.” Comparing the coefficients, we can reject the hypothesis that the differences associated with family/friends are the same as the differences associated with the other levels considered all together with $p = .045$ (Seemingly Unrelated Regression framework for testing linear hypotheses across equations [48]). However, we do not have strong evidence that the neighborhood perceptions are more powerful than even larger groups (city and state perceptions combined, $p = .39$) or that the city effect differs from the state effect ($p = .35$).

Study 2

Since Study 2 happened after some respondents were eligible for vaccines, intentions to vaccinate were only asked of people who did not report having started vaccination. The outcome variable used here is coded 1 if a person had already begun vaccinations or responded that they “definitely will” get vaccinated and 0 otherwise. 66% of the population met this criterion; for intentions

among the subset who had not yet been vaccinated, $M = 3.5$, $SD_{\text{unadjusted}} = 1.54$. Figure 3 shows the same pattern seen in Study 1—perceptions of others’ vaccination intentions predict own vaccination intention or behavior—with the exception that here the state effect was indistinguishable from zero (family and friends, $p < .001$; neighbors, $p < .001$; city, $p = .03$; state, $p = .17$). For example, a difference of 1 unit in perceptions of vaccination intentions among family members produces a .09 percentage point difference in the outcome; a 6 unit difference, the maximum difference between any two people in a pair, would increase the proportion of people who definitely would vaccinate or already have by $6 \times .09 = .54$ if all perception differences were this large. The pattern of decreasing yet still strong relationships also appears. Note that effect sizes are not directly comparable to those in Study 1 because the outcome measure here is dichotomous rather than continuous.

Figure 3 also shows that among Republicans, the social norms/intentions relationship for co-partisans is similar to other close groups.³ Overall, the effect of beliefs about Republican co-partisans is second in magnitude behind that of family and friends ($p = .045$). The same pattern does not hold among Democrats ($p = .551$). Perceptions of the intentions of out-partisan others also show no discernible effect: The Republican within the Republican pair who thinks that Democrats are more likely to be vaccinated is no more or less likely to report that she will be vaccinated than the Republican who thinks that Democrats are not likely to be vaccinated ($p = .942$), and vice versa for Democrats ($p = .871$).

³ Independents were excluded from the party ID analysis for conceptual and methodological reasons. Conceptually, self-assignment to this group implies a desire to stand apart from a bipolar conception of political identity, so it is ambiguous whether Independents count as outpartisans to Democrats or Republicans. But sidestepping this issue by including them in *both* outpartisan groups yields an analysis where individuals are counted twice.

Sensitivity to Hidden Bias

Both studies showed relationships between perceived social norms and vaccination intentions increasing in strength as the norm-holders grow closer or more personally relevant to the individual. And the relationship between perceptions and confounding common causes was consistent with that of a randomized experiment, thus minimizing the likelihood that measured factors explain away social norms effects. Of course, we did not randomly place perceptions of social norms into people's heads, and the possibility that some unmeasured factor causes both different vaccination intentions and different beliefs about others' intentions remains.

While we cannot name or measure this potential variable, we can assess how strong its relationship with perceived social norms and vaccination intentions would have to be to qualitatively change our results (i.e., to make the social norms/intentions relationship indistinguishable from zero in our hypothesis tests). Rosenbaum and Silber (49) use Δ to reflect how an unobserved covariate might increase the odds of a positive difference in *outcome* within-pair and Λ to reflect the same for *treatment* within-pair. For present purposes, Δ is the odds that the person with higher vaccination intentions has them because of an unobserved covariate, and Λ is the odds that the person with higher social norms perceptions has them because of this unobserved covariate. The family/friends perceptions relationship was most resistant to hidden bias in both studies ($\Lambda = 4.5$, $\Delta = 14.7$ in Study 1; $\Lambda = 3.1$, $\Delta = 5.9$ in Study 2). Thus in Study 1, only a hidden factor that increases the odds of being the higher perceiver by 4.5 times and of being more likely to vaccinate by 14.7 times would change the observed p -value from $< .0000001$ to $.051$.⁴

Across all perceived social norms variables for which the strength of the relationships was

⁴ This is equivalent to a value of $\Gamma=3.5$ for Rosenbaum's sensitivity parameter, using the Rosenbaum and Silber (49) approach to decompose Γ into two parts: an effect on treatment or selection (here, perception rank within-pair) and outcome (here, outcome rank within-pair).

detectably different from zero, even the weakest relationships would need an unobserved covariate with at least $\Delta = 2.5$ and $\Delta = 2.4$ (perceptions of state-level norms in Study 1) and at least $\Delta = 2.1$ and $\Delta = 1.5$ (perceptions of city-level norms in Study 2).

To put this result in perspective, we examined a variable that was not included in the pair-matched design but could account for differences in both vaccination intentions and perceived social norms: risk perception (50). We calculated the odds of reporting greater social norm perceptions and vaccination intentions given higher perceptions of the risk of becoming infected with COVID-19 over the next month (0-100% chance) or of experiencing severe side effects from the COVID-19 vaccine (agreement on a 1 to 5 scale that “Getting vaccinated would put me at risk for vaccine side effects”). These odds ratios can then be directly compared with the values that would change the results from significant to non-significant (Δ and Λ) and hence provide evidence that risk perception explains away the results. Among all odds ratios capturing relationships between risk perception and either vaccination intention or social norms perceptions, the largest was 1.88, yet the smallest required by the sensitivity analysis was 2.2. Thus differences in risk perception within-pair do not seem to threaten our interpretation (see [Supplemental Materials S8](#)).

False consensus and directionality

Another possibility is that the results could be wholly or partly due to “false consensus” effects (30). In this view, social norms are not driving health behaviors; rather, people believe that others do what they themselves plan to do and respond to our questions by inferring from their own intentions. Although we cannot definitely settle questions of directionality in these cross-sectional studies, the false consensus hypothesis makes a prediction that we can investigate using our data. If perceptions of others are dictated by people’s own intentions, then we would

expect respondents with the most extreme intentions to have the least accurate perceptions because they systematically over- or underestimate others' intentions. To test this, we calculated accuracy scores for the population from which respondents were drawn for Study 2 by comparing respondents' estimates of how many people in a group would get vaccinated with independent estimates of the vaccination intentions for these same groups; this was only possible at the state level, as no independent survey data were available for cities, neighborhoods, or families and friends groups. Respondents received a 1 if their estimates of how many people in their state intended to get vaccinated were close to independent, contemporaneous survey estimates and a 0 if not (see [Supplementary Materials S5](#)). Accuracy was operationalized as choosing the response option closest to the independent survey estimate on either side; in other words, if the true state-level estimate at the time was 63% (as it was for Alabama), then either "About half" or "About three quarters" would count as correct. We then created a variable dividing the sample into one group consisting of those who gave the most extreme responses regarding their own intentions (5 = *Definitely will* and 1 = *Definitely won't*) and another consisting of people with moderate ratings (2, 3, or 4). Against the prediction from false consensus, people with the strongest pro- or anti-vaccination intentions were not more likely to provide incorrect state-level estimates (in either direction) than people with moderate intentions, $\chi^2(1) = 2.15, p = .14$. And the direction of these weak differences were inconsistent with the false consensus hypothesis: more people in the "extreme" categories for own-vaccination (64.8%) than people with moderate views (60%) gave accurate estimates.

Discussion

Using a quasi-experimental design with surveys conducted at different points in the COVID-19 pandemic and vaccine rollout, we find that beliefs about others' intentions to get vaccinated

predict people's own intentions even when holding constant demographic variables that reflect risk of poor COVID-19 outcomes (gender [32]; race [32-34]; age [26]; education [35]; family income [33, 36]) as well as variables that have been shown to predict COVID-19 health behaviors even though they are not associated with differential risk (partisan identity [27, 37]; political ideology [38]; trust in science [39, 40]; trust in government [38]; religiosity [38]; COVID-19 knowledge [43]; and subjective assessments of that knowledge [44]). Moreover, *who* those others are—one's friends and family, neighbors, city or state co-residents—dictates the strength of the relationship, which declines as the groups get larger and more diffuse. This pattern is consistent with some existing health behavior models—the Theory of Planned Behavior, for instance, predicts that social norms will factor into decision making to the extent they are associated with personally significant referents (51), while the Theory of Normative Social Behavior (52) similarly expects group identification to modulate effects of descriptive norms on behaviors—and has been observed in a social norms study on energy consumption (53, as reported in 54). Among Republicans, beliefs about co-partisans' intentions predicted people's own intentions with magnitudes between the “friends or family” and “neighbors” relationships. Beliefs about out-partisans appeared irrelevant to vaccination intentions for Democrats and Republicans. A sensitivity analysis shows that if both perceived social norms and vaccination intentions were caused by some unmeasurable variable, the effect of this variable would have to be extremely large to change the interpretation. And a prediction from the false consensus hypothesis (i.e., that intentions cause social norms perceptions rather than the other way around) was not supported.

One limitation of our studies is that they cannot speak to mechanisms. It is unknown whether people's vaccination intentions are influenced by perceived social norms due to desire for reward or fear of sanction from one's community, to social learning, or to some other mechanism. Another limitation is that our measures do not distinguish family from friends; it is possible that

the two groups' intentions would show different relationships with people's own intentions. Finally, our study measured intentions to get vaccinated rather than actual vaccinations. The gap between intentions and behaviors has been substantial in other vaccination contexts like seasonal flu (55) or H1N1 (56). However, recent results suggest this gap is much smaller for COVID-19. A study from Sweden linking survey responses with subsequent vaccination records found a roughly 10 percentage point discrepancy between intentions and actions (57). Comparisons of self-reported vaccination status with previously measured intentions show a very similar correspondence in US samples (58, 59) but a larger gap in China (60). Thus while people's stated intentions almost certainly overestimate subsequent behaviors to some extent, in the case of COVID-19, the extent does not render them uninformative.

These results have implications for both social norms research and public health policy. Although studies have shown effects of perceived others' beliefs on people's own COVID-related behaviors, the means of operationalizing "others" have run the gamut from family or friends (15) to fellow nationals (18) to all of humankind (22). We find that these distinctions matter for vaccination, the most critical COVID-related health behavior. Researchers studying social norms and public health should measure perceived social norms of multiple groups and consider how the characteristics of the respondent match those of the groups.

Policy implications are more complex. Most straightforwardly, public health communications that use social norms information cannot treat various groups as interchangeable. Messages reporting how many people in one's country have been vaccinated may show less influence than those reporting numbers at the state level, which in turn may show less influence than those reporting city numbers. A similar distinction among reference groups is seen in COVID-related messages using imperatives (e.g., "do it for your community" versus "do it for your family" [61, 62]).

The social norms/vaccination relationship was unequivocally strongest for the friends and family group in both studies, and convergent survey evidence is consistent with this finding. In April 2021, the KFF COVID-19 Vaccine Monitor found that among 18-29-year-olds, 68% who reported that more than half of their friends had been vaccinated were themselves vaccinated, while the number was just 19% for people reporting less than half of their friends had been vaccinated (63). Similarly, in June 2021, 77% of vaccinated adults said that everyone in their household had been vaccinated, while 75% of unvaccinated adults said that *no one* in their household had been vaccinated (64). Public health authorities hoping to employ social norms in messaging therefore face a problematic choice between making implausible claims about people's close social ties (how could a health department official know what my family did?) and making plausible but weaker claims about larger, more diffuse groups. Indeed, assertions about social norms in larger groups have fared poorly in the literature. Moehring and colleagues (13) presented a large, multinational sample ($N = 437,236$) with percentages in people's regions that intended to get vaccinated against COVID-19 as estimated on a prior survey. This information yielded a small increase in stated vaccination intentions, but the gains were driven by less than half of the countries, the US not among them. Sinclair & Agerström (14) manipulated rather than reported the proportions (85% versus 45%) of "people in general" or people in respondents' age groups intending to get vaccinated; neither stated proportion increased intentions relative to control in a UK sample. Using a similar manipulation, Sasaki et al. (65) find no effect among Japanese respondents. Directly informing people of the vaccination status of their close ties, as Gerber et al. (66) did with past voting behavior, is not possible given the medically sensitive nature of the information. And since we find no evidence that *misperceived* social norms are associated with intentions, interventions that have targeted other risky behaviors (e.g., excessive drinking [67]) by

correcting perceptions may yield little return for vaccination (although future work should test this assumption about people's closest ties, for instance by using snowball sampling).

But evidence from non-COVID vaccine studies suggests that *demonstrating* social proof at the individual level, rather than asserting it in blanket messaging about groups, could be effective. Badges indicating who had been vaccinated against seasonal flu may increase vaccine uptake among healthcare workers (68, 69); notably, blanket messages in letters mailed to healthcare workers do not (70). Conceptually similar interventions have been effective at increasing voter turnout. People who saw that a number of their Facebook friends had voted were in turn more likely to vote (71). Note however that (68) and (69) did not test social proof in perfect isolation, as the interventions contained several features (e.g., healthcare workers who did not get vaccinated were required to wear masks). And elections are discrete events, but vaccination campaigns are ongoing, so stronger and less transient interventions than, e.g., "I got vaccinated" stickers distributed at vaccination sites are probably required. Researchers might look to more elaborate interventions exploiting first-degree ties from other domains. For instance, Paluck et al. (72) found that conducting conflict-reduction workshops with adolescent students but allowing the students to develop their own peer-facing strategies and materials reduced the frequency of fights recorded by school administrations. The context-specific nature of such approaches is appealing given the dynamic nature of social norms (73). Interventions that exploit the structure of normholders' networks may also be fruitful (74); see for instance (75).

The strong relationship between beliefs about co-partisans' behaviors and people's own intentions among Republicans, a group that has been consistently less likely to vaccinate against COVID-19 (27), suggests that explicit partisan appeals could increase uptake. But it is unclear whether the sort of "elite cues" (i.e., messages from leaders) that have shown promise in survey experiments (76, 77) would fulfill this function. Recall that we asked about vaccination intentions

of Democrats, Republicans, and Independents generally, not the intentions of group leaders. We doubt that pro-vaccination messages from delegates of groups more often associated with anti-vaccination attitudes would *hurt* campaigns to encourage vaccination. But the most promising interventions are those that harness the power of social proof demonstrated by the co-partisans that people are most likely to trust: their family and friends.

Materials and methods

Populations, COVID-19 Context, and Data Sources

Data for Study 1 come from surveys fielded by YouGov for The Policy Lab and Rhode Island Department of Health, November 10-17 and December 11-20, 2020. The November survey included 500 Rhode Island residents and 1,000 non-RI US residents; the December survey included 500 RI residents only. Because the behavior of 18-29-year-olds was a policy concern at the time, we also oversampled young adults through outreach to colleges and universities; 694 respondents voluntarily completed an identical Qualtrics survey. The first COVID-19 vaccine was approved December 11 and became available to healthcare workers and select others shortly after. Data for Study 2 come from a similar survey also fielded by YouGov and conducted March 18-31, 2021, with 500 RI residents and 1,000 non-RI US residents. At this time, older residents and those with underlying conditions had become eligible for vaccination. This research was classified as public health surveillance by the Brown University IRB and thus was exempt from review.

Measures

We measured *perceived social norms* in Study 1 by asking respondents four questions: “How many people in ____ do you believe will definitely get vaccinated? (Give your best estimate.)” with the

blank filled by “your network of family and friends,” “your neighborhood,” “your city or town,” and “your state” on a scale 1–7 scale (1 = *None*, 2 = *A few (less than a quarter)*, 3 = *About a quarter*, 4 = *About half*, 5 = *About three quarters*, 6 = *Most (more than three quarters)*, 7 = *All*). Study 2 included these questions and added perceptions of three partisan groups (“How many Republicans/Democrats/Independents do you believe will definitely get vaccinated?”).

Because data for Study 1 were collected before COVID-19 vaccines were approved, we measured respondents’ own *vaccine intentions* by asking, “If and when a coronavirus vaccine becomes available, will you get vaccinated?” (1 = *Definitely won’t*, 2 = *Maybe won’t*, 3 = *Not sure*, 4 = *Maybe will*, 5 = *Definitely will*). Since vaccines were available to some groups at the time of Study 2, vaccine intentions were measured by creating a composite variable with value 1 if a respondent either reported having begun vaccination or responded “Definitely will” when asked “Are you going to get vaccinated for coronavirus as soon as it’s possible to do so?” (same scale as Study 1), and value 0 otherwise. See [Supplementary Materials S2](#) for an analysis using the continuous rather than dichotomous composite variable; results do not differ.

Trust in science was captured by calculating the average across two questions (trust in information from public health scientists, how much scientists understand COVID-19). Trust in government was measured by averaging across trust in federal, state, and local government. COVID-19 knowledge was measured using an eight-item true/false knowledge battery, while subjective assessments of knowledge came from a single question asking how much respondents understand COVID-19 (Study 1) or COVID-19 vaccines (Study 2). See [Supplementary Materials S3](#) for question wordings and <https://osf.io/8dnjs/> for complete survey instruments.

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Figures and tables

Figure 1. Groups to which an individual belongs form partially overlapping sets. Sizes of circles represent both size of the set and the “closeness” of the group (personal relevance, homogeneity).

Table 1: Tests of mean differences between rank-ordered higher and lower perceivers of social norms for continuous variables used to match respondents in Study 1 (top) and Study 2 (bottom).

	variable	mean lower perceiver	mean higher perceiver	difference	standardize d difference	<i>p</i>	<i>p</i> adj.
Study 1	Lib/Con Ideology	3.02913	3.03641	0.007282	0.005408	0.8877	1
	Age	48.89563	48.71845	-0.177184	-0.010232	0.5336	1
	Family income	6.28155	6.32039	0.038835	0.012427	0.6716	1
	Education	3.67718	3.73301	0.055825	0.038231	0.1319	1
	Trust in science	3.90655	3.90655	0.000000	0.000000	1.0000	1
	COVID-19 knowledge	0.76335	0.77063	0.007282	0.052088	0.3883	1
	Subjective COVID-19 knowledge	3.97573	3.97573	0.000000	0.000000	1.0000	1
	Religiosity	0.32949	0.33568	0.006189	0.033275	0.5565	1
	Family income missingness	0.07767	0.06553	-0.012136	-0.047026	0.2971	1
	COVID-19 knowledge missingness	0.06068	0.06068	0.000000	0.000000	1.0000	1
	Subjective COVID-19 knowledge missingness	0.93932	0.93932	0.000000	0.000000	1.0000	1
Study 2	Lib/Con ideology	3.0843	3.1064	0.0220884	0.0155571	0.4875	1
	Age	50.2952	50.4137	0.1184739	0.0069468	0.5349	1
	Family income	6.1265	6.1245	-0.0020080	-0.0006334	0.9802	1
	Education	3.7048	3.6827	-0.0220884	-0.0151481	0.6692	1
	Trust in government	2.2533	2.2537	0.0003347	0.0005367	0.9880	1
	Trust in science	3.8996	3.9217	0.0220884	0.0221226	0.3447	1
	Subjective COVID-19 knowledge	3.4920	3.4679	-0.0240964	-0.0260201	0.6534	1
	Religiosity	0.5030	0.5068	0.0037830	0.0128432	0.8171	1
	Family income missingness	0.1145	0.1225	0.0080321	0.0248313	0.5791	1

Figure 2. Left panel: Study 1 average relationships within-pair between a 1 unit difference in perceptions of vaccination intentions of others (0 = No one in the group will definitely vaccinate to 6 = All people in the group definitely will vaccinate) on own-intention (1 = definitely won't vaccinate to 5 = definitely will vaccinate) for the pair-matched design ($N = 824$) and the full valid data ($N = 1,992$). Right panel: point estimates from the paired-design plus 95% confidence intervals created with HC2 standard errors. All p -values for the null hypothesis of no effects $<.001$, two-tailed.

Figure 3: Left panel: Study 2 average relationships within-pair between a 1 unit difference in perceptions of vaccination intentions of others (0 = No one in the group will definitely vaccinate to 6 = All people in the group definitely will vaccinate) on own-intention or behavior (1 = definitely will vaccinate/has already vaccinated, 0 = otherwise) for the pair-matched design ($N = 996$) and the full valid data ($N = 1,497$). Right panel: point estimates from the paired-design plus 95% confidence intervals created with HC2 standard errors. Note that coefficient magnitudes reflect the dichotomous outcome measure, in contrast to the continuous measure in Study 1.

Supplementary materials

S1. Deviations from the pre-analysis plan

These analyses were pre-registered at <https://osf.io/fqvp3>. We deviate from the analysis plan in two ways. First, since the primary focus of the paper is perceived social norms as a function of group rather than the accuracy of those perceptions, we have opted for the simpler means of calculating accuracy. While the pre-analysis plan stated that we would use either multilevel regression with poststratification or independent survey estimates to operationalize accuracy, here we use only the latter (see [section S5](#)).

Second, the pre-analysis plan designated only demographics as variables used to pair respondents in the matched design. Rather than overlook other measured dimensions that could plausibly explain away perceived social norms/vaccination intentions relationships, we chose to add additional measures from the surveys—specifically, trust in science ([Koetke et al., 2021](#); [Plohl & Musil, 2020](#); [Stosic et al., 2021](#)), trust in government ([Han et al., 2021](#); [Pagliaro et al., 2021](#)), religiosity ([Milligan et al., 2021](#); [Olagoke et al., 2020](#)), COVID-19 knowledge ([Ning et al., 2020](#)), and subjective assessments of that knowledge ([Motoki et al., 2021](#)). Figure S1 shows that the patterns are the same without these additional variables, with one exception: Democrats displayed a strong relationship between perceived social norms of co-partisans and their own vaccination intentions that vanished once respondents were further matched on trust in science, trust in government, religiosity, COVID-19 knowledge, and subjective assessments of COVID-19 knowledge. In other words, for Democrats but not Republicans, the influence of perceived social norms on people's own vaccination intentions covaries with one or all of these dimensions.

Figure S1. Point estimates from the paired-design using only demographic variables for Study 1 (left) and Study 2 (right). 95% confidence intervals were created with HC2 standard errors.

S2. Does using a continuous rather than binary outcome variable in Study 2 alter the results?

Study 1 uses a continuous measure of intention to get vaccinated as an outcome variable, while Study 2 addressed the fact that some respondents had received vaccines by creating a composite, dichotomous variable with value 1 if a respondent *either* had begun vaccination *or* reported that they definitely would get vaccinated, and value 0 otherwise. To ensure that the latter operationalization did not distort the results, we show below that the pattern is the same using the continuous measure given only to the subset of respondents who did not report having begun or completed vaccination) or the dichotomous measure in Study 2.

	Dichotomous variable		Continuous variable	
	<i>Standardized β</i>	<i>Sig.</i>	<i>Standardized β</i>	<i>Sig.</i>
Network of friends & family	.517	<.001	.603	<.001
Gender (female)	-.036	.081	-.059	.021
Party (Republican)	-.111	<.001	-.117	<.001
Party (Independent)	-.073	.001	-.079	.005
Race/ethnicity (Black)	-.02	.351	-.007	.787
Race/ethnicity (Latino)	.009	.683	.041	.124
Education (No HS)	-.044	.045	.012	.663
Education (HS)	-.108	<.001	-.029	.357
Education (Some college)	-.088	<.001	-.032	.29
Education (2-year degree)	-.059	.01	-.05	.09
Age	.099	<.001	-.104	<.001

Table S2.1. Multiple regression with dichotomous variable (already vaccinated or “Definitely will” = 1, otherwise 0) or continuous variable (Intention to get vaccinated, 1-5 scale from “Definitely won’t” to “Definitely will”) as outcome variable and perceived friends’ and family’s intentions as well as demographics as predictors in Study 2.

	Dichotomous variable		Continuous variable	
	<i>Standardized β</i>	<i>Sig.</i>	<i>Standardized β</i>	<i>Sig.</i>
Neighborhood	.353	<.001	.444	<.001
Gender (female)	-.031	.166	-.066	.02
Party (Republican)	-.166	<.001	-.194	<.001
Party (Independent)	-.101	<.001	-.112	<.001
Race/ethnicity (Black)	-.059	.011	-.062	.038
Race/ethnicity (Latino)	-.024	.293	.006	.84
Education (No HS)	-.062	.009	-.006	.852
Education (HS)	-.171	<.001	-.1	.004
Education (Some college)	-.122	<.001	-.076	.024
Education (2-year degree)	-.099	<.001	-.089	.006
Age	.142	<.001	-.079	.008

Table S2.2. Multiple regression with dichotomous variable (already vaccinated or “Definitely will” = 1, otherwise 0) or continuous variable (Intention to get vaccinated, 1-5 scale from “Definitely won’t” to “Definitely will”) as outcome variable and perceived neighbors’ intentions as well as demographics as predictors in Study 2.

	Dichotomous variable		Continuous variable	
	<i>Standardized β</i>	<i>Sig.</i>	<i>Standardized β</i>	<i>Sig.</i>
City or town	.303	<.001	.402	<.001
Gender (female)	-.044	.057	-.078	.008
Party (Republican)	-.18	<.001	-.201	<.001
Party (Independent)	-.099	<.001	-.106	.001
Race/ethnicity	-.071	.003	-.07	.02

(Black)				
Race/ethnicity (Latino)	-.026	.269	.004	.897
Education (No HS)	-.09	<.001	-.037	.226
Education (HS)	-.19	<.001	-.116	.001
Education (Some college)	-.13	<.001	-.086	.012
Education (2-year degree)	-.112	<.001	-.104	.002
Age	.155	<.001	-.088	.004

Table S2.3. Multiple regression with dichotomous variable (already vaccinated or “Definitely will” = 1, otherwise 0) or continuous variable (Intention to get vaccinated, 1-5 scale from “Definitely won’t” to “Definitely will”) as outcome variable and perceived city residents’ intentions as well as demographics as predictors in Study 2.

	Dichotomous variable		Continuous variable	
	<i>Standardized β</i>	<i>Sig.</i>	<i>Standardized β</i>	<i>Sig.</i>
State	.236	<.001	0.344	<.001
Gender (female)	-.038	.104	-.07	.02
Party (Republican)	-.199	<.001	-.219	<.001
Party (Independent)	-.112	<.001	-.128	<.001
Race/ethnicity (Black)	-.076	.002	-.078	.012
Race/ethnicity (Latino)	-.029	.223	-.007	.832
Education (No HS)	-.107	<.001	-.061	.055
Education (HS)	-.211	<.001	-.13	<.001
Education (Some college)	-.144	<.001	-.102	.004
Education (2-year degree)	-.119	<.001	-.108	.001

Age	.174	<.001	-.096	.002
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Table S2.4. Multiple regression with dichotomous variable (already vaccinated or “Definitely will” = 1, otherwise 0) or continuous variable (Intention to get vaccinated, 1-5 scale from “Definitely won’t” to “Definitely will”) as outcome variable and perceived state residents’ intentions as well as demographics as predictors in Study 2.

S3. Non-demographic measures used

<i>Dimension</i>	<i>Question(s)</i>	<i>Scale</i>
Perceived social norms: friends & family	How many people in ____ do you believe will definitely get vaccinated? (Give your best estimate.)	1 = None, 2 = A few (less than a quarter), 3 = About a quarter, 4 = About half, 5 = About three quarters, 6 = Most (more than three quarters), 7 = All
Perceived social norms: neighbors	How many people in ____ do you believe will definitely get vaccinated? (Give your best estimate.)	
Perceived social norms: fellow city residents	How many people in ____ do you believe will definitely get vaccinated? (Give your best estimate.)	
Perceived social norms: fellow state residents	How many people in ____ do you believe will definitely get vaccinated? (Give your best estimate.)	
Perceived social norms: Democrats (Study 2 only)	How many people in ____ do you believe will definitely get vaccinated? (Give your best estimate.)	
Perceived social norms: Republicans (Study 2 only)	How many people in ____ do you believe will definitely get vaccinated? (Give your best estimate.)	
Perceived social norms: Independents (Study 2 only)	How many people in ____ do you believe will definitely get vaccinated? (Give your best estimate.)	
Vaccination intentions (Study 1)	If and when a coronavirus vaccine becomes available, will you get vaccinated?	1 = Definitely won't, 2 = Maybe won't, 3 = Not sure, 4 = Maybe will, 5 = Definitely will
Vaccination intentions (Study 2)	(a) Have you been vaccinated for coronavirus already, either partially or fully? <i>Respondents who answer "No" were asked:</i> (b) Are you going to get vaccinated for coronavirus as soon as it's possible to do so?	1 = either "Yes" on (a) or "Definitely will" on (b) 0 = all else
Trust in science	<i>Average across:</i> (a) How would you rate (in general) scientists' knowledge about Covid-19 vaccines? (b) How reliable do you consider the information about coronavirus coming from public health scientists?	(a) 1 = No knowledge whatsoever, 2 = A little knowledge, 3 = Some knowledge, 4 = Fairly knowledgeable, 5 = Extremely knowledgeable (b) 1 = Very unreliable, 2 = Somewhat unreliable, 3 = Neither unreliable nor reliable, 4 = Somewhat reliable, 5 = Very reliable
Trust in government	<i>Average across:</i>	1 = None of the time, 2 = Some of the

(Study 2)	<p>(a) How much of the time do you think you can trust the federal government to do what is right?</p> <p>(b) How much of the time do you think you can trust the state government to do what is right?</p> <p>(c) How much of the time do you think you can trust the local government to do what is right?</p>	<i>time, 3 = Most of the time, 4 = Just about always</i>
COVID-19 knowledge (Study 1)	<p><i>Score on:</i></p> <p>(a) A virus is considered airborne when a person can be infected from particles suspended in the air for minutes to hours after an infected person has been in the room. (T)</p> <p>(b) Covid-19 spreads mainly through droplets from an infected person at close range that are directly inhaled. (T)</p> <p>(c) Use of ozone generators is more effective than ventilation to remove viruses from enclosed spaces. (F)</p> <p>(d) Dirty laundry from a person who is sick with Covid-19 should be washed separately from other people's items. (F)</p> <p>(e) People who develop long-lasting changes in smell and taste after contracting Covid-19 are at increased risk of developing a severe disease. (T)</p> <p>(f) Advanced age is a factor of risk for developing a severe form of Covid-19. (T)</p> <p>(g) Everybody under 25 years of age, even if infected, will not develop a severe form of Covid-19. (F)</p> <p>(h) People who had Covid-19 cannot get infected again with the novel coronavirus. (F)</p>	<i>True/false</i>
COVID-19 knowledge self-assessment (Study 1)	How would you rate your knowledge about the coronavirus and Covid-19?	<i>1 = No knowledge whatsoever, 2 = A little knowledge, 3 = Some knowledge, 4 = Fairly knowledgeable, 5 = Extremely knowledgeable</i>
COVID-19 knowledge self-assessment (Study 2)	How would you rate your knowledge of Covid-19 vaccines?	

S4. Does the matched design approximate a pair-randomized experiment?

Study 1

In the main paper, we report the results of omnibus tests of the null hypothesis of no differences between the members of a matched pair's covariate values taken all together and one-by-one tests of the null hypothesis of no difference between the higher and lower perceivers within pairs. We also show below, in Table S4.1, that within-pair differences were not large in substantive terms. For each covariate the table shows the distribution of within-pair differences on the scale of the given variable using percentiles as well as the original scale of the variable. We see, for example, that half of the pairs differed by less than 1 point on the 6 point ideology scale, 10% of the pairs differed by as much as 2 points on the ideology scale, but none differed by more than 2 points (the 100% column). While Table 1 and the omnibus test show that the pair-differences in covariates remaining after matching in this design are consistent with those we would see if we had randomized the role of higher perceiver within-pair (as discussed above), Table S4.1 shows that none of the within-pair differences are substantively large either: no pair differed by more than .5 of a scale point on the 5-point trust in science scale, 3 points on the 16-point family income scale, or 9 years of age.

Covariate	10%	50%	90%	100%	Min	Max
Lib/Con Ideology	0.00	1.00	2.00	2.00	1.000	6
Education	0.00	1.00	1.00	1.00	1.000	6
Age	1.00	5.00	9.00	10.00	18.000	90
Family Income	0.00	1.04	3.00	3.00	1.000	16
Missing Family Income	0.00	0.00	0.00	1.00	0.000	1
Trust In Science	0.00	0.00	0.00	0.00	1.000	5
COVID Knowledge	0.00	0.12	0.25	0.38	0.125	1
Missing Covid Knowledge	0.00	0.00	0.00	0.00	0.000	1
COVID Subjective Knowledge	0.00	0.00	0.00	0.00	1.000	5
Missing COVID Subjective Knowledge	0.00	0.00	0.00	0.00	0.000	1
Religiosity	0.02	0.15	0.36	0.45	0.000	1

Table S4.1: Percentiles of differences within pairs after matching (Study 1). The Min and Max columns show the range of the variable before matching. Pairs were exactly the same on Democrat, Republican, Other; Female vs. Male; White, Black, Latino, other race; and survey wave. After matching, pairs were the same on Self-assessed COVID-19 knowledge, Missing subjective COVID-19 knowledge, and Missing COVID-19 knowledge.

Importantly, this design does *not* isolate any potential differences in perceptions arising from variables that we did not observe. The higher perceiver within a pair may differ from the lower perceiver for reasons other than party, ideology, education, gender, COVID-19 knowledge, or any other variable in Table S4.2. Indeed, the premise of the design is that different perceptions of others' behavior come from somewhere other than the observable respondent traits. The key question for inference is whether an unobserved variable that is not strongly related to those we have controlled for causes both different perceptions of others' behavior and different vaccination intentions within the pair. In the main paper ([Sensitivity to Hidden Bias](#)), we ask how much bias from such unobserved variables would be necessary to change the substantive interpretation of our results as a way to help readers reason about this issue.

Study 2

Table S4.2 shows the range of within-pair differences remaining on key covariates after matching. For example, half of the pairs differ by less than .5 on the 6 point ideology scale (and none more than 1 point), 1 point on the 6 point education scale (and none more than 2 points), 4 years of age (and none more than 7 years of age), etc.

Covariate	10%	50%	90%	100%	Min	Max
Lib/Con Ideology	0.00	1.00	1.00	1.00	1	6
Education	0.00	1.00	2.00	2.00	1	6
Age	1.00	4.00	7.00	7.00	19	94
Family Income	0.00	1.06	3.00	3.00	1	16
Missing Family Income	0.00	0.00	1.00	1.00	0	1
Trust In Science	0.00	0.50	1.00	1.00	1	5
Trust in Government	0.00	0.33	1.00	1.00	1	4
COVID Subjective Knowledge	0.00	1.00	2.00	3.00	1	5
Religiosity	0.03	0.25	0.61	0.92	0	1

Table S4.2. Percentiles of differences within pairs after matching (Study 2). The Min and Max columns show the range of the variable before matching.

S5. Are perceptions of others' vaccination intentions accurate?

S5.1. Operationalizing accuracy

Assigning individual respondents a score indicating the accuracy of their estimates of proportions of others that will definitely get vaccinated requires independent estimates of those proportions at the time of data collection. For accuracy of *state-wide estimates*, we use the US Census Household Pulse Survey's state-by-state breakdowns of proportions of adults who have not been vaccinated but responded that they "definitely will" once vaccines are available to them. This question was added to the HPS in January 2021, so we examine accuracy of respondents' estimates only for the data collected in Study 2 (March, 2021). Raw data for the comparable period (Week 27, March 17–29, 2021) are publicly available at <https://www.census.gov/programs-surveys/household-pulse-survey/datasets.html>. We have also reproduced these files in our public code repository, which also includes analysis code for creating the accuracy variable included in the Supplementary Materials code file (github.com/thepolicylab/COVID-VaccinesSocialNorms). The table below shows how we operationalized the accuracy of a respondent's estimate for the percentage in their state that will definitely get vaccinated.

<i>State</i>	<i>Rec'd a COVID-19 vaccine or definitely will (HPS)</i>	<i>Responses coded as accurate if selected</i>
Alabama	64.30%	4 About half, 5 About three quarters
Alaska	68.60%	4 About half, 5 About three quarters
Arizona	68.10%	4 About half, 5 About three quarters
Arkansas	66.60%	4 About half, 5 About three quarters
California	78.40%	5 About three quarters, 6 Most (more than three quarters)
Colorado	73.90%	4 About half, 5 About three quarters
Connecticut	80.40%	5 About three quarters, 6 Most (more than three quarters)
Delaware	72.10%	4 About half, 5 About three quarters
D.C.	83.70%	5 About three quarters, 6 Most (more than three quarters)

Florida	67.50%	4 About half, 5 About three quarters
Georgia	64.20%	4 About half, 5 About three quarters
Hawaii	75.80%	5 About three quarters, 6 Most (more than three quarters)
Idaho	65.30%	4 About half, 5 About three quarters
Illinois	75.80%	5 About three quarters, 6 Most (more than three quarters)
Indiana	68.00%	4 About half, 5 About three quarters
Iowa	71.00%	4 About half, 5 About three quarters
Kansas	69.60%	4 About half, 5 About three quarters
Kentucky	67.80%	4 About half, 5 About three quarters
Louisiana	62.40%	4 About half, 5 About three quarters
Maine	75.30%	5 About three quarters, 6 Most (more than three quarters)
Maryland	74.00%	4 About half, 5 About three quarters
Massachusetts	79.60%	5 About three quarters, 6 Most (more than three quarters)
Michigan	70.50%	4 About half, 5 About three quarters
Minnesota	76.70%	5 About three quarters, 6 Most (more than three quarters)
Mississippi	60.40%	4 About half, 5 About three quarters
Missouri	70.80%	4 About half, 5 About three quarters
Montana	63.00%	4 About half, 5 About three quarters
Nebraska	69.20%	4 About half, 5 About three quarters
Nevada	66.90%	4 About half, 5 About three quarters
New Hampshire	82.20%	5 About three quarters, 6 Most (more than three quarters)
New Jersey	73.40%	4 About half, 5 About three quarters
New Mexico	80.00%	5 About three quarters, 6 Most (more than three quarters)
New York	77.20%	4 About half, 5 About three quarters
North Carolina	70.90%	4 About half, 5 About three quarters
North Dakota	66.10%	4 About half, 5 About three quarters
Ohio	69.90%	4 About half, 5 About three quarters
Oklahoma	65.40%	4 About half, 5 About three quarters

Oregon	74.10%	4 About half, 5 About three quarters
Pennsylvania	68.20%	4 About half, 5 About three quarters
Rhode Island	77.20%	5 About three quarters, 6 Most (more than three quarters)
South Carolina	65.80%	4 About half, 5 About three quarters
South Dakota	74.90%	4 About half, 5 About three quarters
Tennessee	66.60%	4 About half, 5 About three quarters
Texas	70.30%	4 About half, 5 About three quarters
Utah	68.90%	4 About half, 5 About three quarters
Vermont	81.10%	5 About three quarters, 6 Most (more than three quarters)
Virginia	76.80%	5 About three quarters, 6 Most (more than three quarters)
Washington	76.00%	5 About three quarters, 6 Most (more than three quarters)
West Virginia	72.60%	4 About half, 5 About three quarters
Wisconsin	70.90%	4 About half, 5 About three quarters
Wyoming	57.10%	4 About half, 5 About three quarters

Table S5.1. Proportions of people who either received a COVID-19 vaccine or responded that they “definitely will” when it’s possible to do by state in the Household Pulse Survey, March 2021.

For accuracy of *co-partisan* and *out-partisan estimates*, we draw on data from Kaiser Family Foundation’s COVID-19 Vaccine Monitor collected March 15–21, 2021. Topline results are publicly available at

<https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-march-2021/>. Percentages of Democrats and Republicans who responded that they had either been vaccinated already or would get vaccinated as soon as possible were 79% and 46%, respectively (Independents = 57%). We therefore coded perceptions of Democrats’ intentions to get vaccinated correct if respondents answered 5 = *About three quarters* or 6 = *Most (More than three quarters)* and coded perceptions of Republicans’ intentions correct if respondents answered 3 = *About a quarter* or 4 = *About half* (Independents: 4 = *About half* or 5 = *About three quarters*).

S5.2. Overall accuracy

Using these measures, we find that 66.5% of respondents in Study 2 provided accurate estimates of statewide intentions to get vaccinated. Perceptions were accurate regarding Democrats' intentions to get vaccinated among 63.8% of the sample, regarding Republicans' intentions among 52.8%, and regarding Independents' intentions among 51.9%.

S5.3. Demographics

Age showed a very small correlation with accuracy of perceived statewide intentions, $r(1500) = .091, p < .001$. Differences in accuracy of perceptions by gender, race/ethnicity, and education categories are shown below.

Male ($n = 677$)	Female ($n = 793$)	Other ($n = 17$)	Prefer not to say ($n = 13$)
67.9%	65.7%	64.7%	38.5%

White ($n = 1130$)	Black ($n = 120$)	Hispanic ($n = 139$)	Asian ($n = 34$)	Native American ($n = 8$)	Two or more races ($n = 38$)	Other ($n = 29$)	Middle Eastern ($n = 2$)
69.1%	47.5%	66.2%	50.0%	87.5%	57.9%	69.0%	50.0%

No high school ($n = 62$)	High school graduate ($n = 419$)	Some college ($n = 306$)	2-year degree ($n = 192$)	4-year degree ($n = 322$)	Post-grad degree ($n = 199$)
59.7%	59.2%	61.1%	71.9%	71.7%	78.4%

Table S5.2. Proportions of accurate perceptions of statewide vaccination intentions by demographics.

S5.4. Perception versus accuracy

To directly compare the effects of perceived social norms and the accuracy of those perceptions, we conducted multiple regressions with both factors as well as demographics as predictors and intention to get vaccinated as the outcome. These analyses suggest that perceptions but not their accuracy are driving self-reported intentions.

<i>Predictor</i>	<i>B</i>	<i>Standard error</i>	<i>Standardized β</i>	<i>t</i>	<i>Sig.</i>
State perceived	.090	.010	.226	9.041	< .001
Accuracy of state perceived	.033	.025	.032	1.285	.199
Gender (female)	-.037	.023	-.038	-1.616	.106
Party (Republican)	-.239	.031	-.197	-7.766	< .001
Party (Independent)	-.115	.026	-.112	-4.429	< .001
Race/ethnicity (Black)	-.130	.043	-.073	-3.022	.003
Race/ethnicity (Latino)	-.050	.040	-.030	-1.242	.214
Education (No HS)	-.255	.059	-.105	-4.334	< .001
Education (HS)	-.223	.029	-.207	-7.589	< .001
Education (Some college)	-.169	.032	-.141	-5.363	< .001
Education (2-year degree)	-.173	.037	-.120	-4.685	< .001
Age	.005	.001	.172	7.074	< .001

Table S5.3. Multiple regression with both perceived statewide intentions to get vaccinated and the accuracy of those perceptions included as predictors and own intention to get vaccinated as an outcome.

<i>Predictor</i>	<i>B</i>	<i>Standard error</i>	<i>Standardized β</i>	<i>t</i>	<i>Sig.</i>
Partisan in-group perceived	.106	.012	.321	9.25	< .001
Accuracy of partisan in-group perceived	-.002	.030	-.002	-.067	.947
Gender (female)	-.044	.028	-.048	-1.608	.108

Party (Republican)	-.188	.035	-.194	-5.287	< .001
Race/ethnicity (Black)	-.094	.051	-.058	-1.853	.064
Race/ethnicity (Latino)	-.091	.05	-.056	-1.798	.072
Education (No HS)	-.127	.074	-.052	-1.700	.089
Education (HS)	-.150	.036	-.148	-4.191	< .001
Education (Some college)	-.183	.039	-.155	-4.676	< .001
Education (2-year degree)	-.171	.047	-.118	-3.65	< .001
Age	.003	.001	.096	3.057	.002

Table S5.4. Multiple regression with both perceived co-partisan intentions to get vaccinated and the accuracy of those perceptions included as predictors and own intention to get vaccinated as an outcome (Independents excluded).

S6. Gap between perceived intentions to vaccinate among people in state and people in network of friends & family

We also consider the possibility that the magnitude of difference between perceived statewide intentions and perceived friends' and family's intentions would be associated with respondents' own intentions to vaccinate. We calculated a difference score, $\text{intentions}_{\text{state}} - \text{intentions}_{\text{friends/family}}$. Values indicate the extent to which respondents believe that more people in their state than in their network of friends and family will get vaccinated. The resulting variable was strongly negatively correlated with respondents' own intentions, $r(1500) = -.452, p < .001$. Mean differences by demographics excluding categories with poor representation in the sample ($n < 30$) are shown below.

Male ($n = 677$)	Female ($n = 793$)
-.16	-.20
$t(1468) = .44, p = .659$	

White ($n = 1130$)	Black ($n = 120$)	Hispanic ($n = 139$)	Asian ($n = 34$)	Two or more races ($n = 38$)
-.28	.29	.34	-.44	.26
$F(4, 1456) = 21.82, p < .001$ Significant pairwise comparisons (Bonferroni adjusted): White/Black ($p < .001$) and White/Hispanic ($p < .001$)				

No high school ($n = 62$)	High school graduate ($n = 419$)	Some college ($n = 306$)	2-year degree ($n = 192$)	4-year degree ($n = 322$)	Post-grad degree ($n = 199$)
.55	.14	-.15	-.02	-.48	-.80
$F(5, 1494) = 17.94, p < .001$ Significant pairwise comparisons (Bonferroni adjusted): No high school/some college ($p = .008$) No high school/post-grad ($p < .001$) No high school/4-year ($p < .001$) High school/post-grad ($p < .001$) High school/4-year ($p < .001$) Some college/post-grad ($p < .001$)					

2-year/4-year ($p = .006$) 2-year/post-grad ($p < .001$)

Table S6.1. Mean difference scores showing the extent to which people believe that more people in their state than in their network of friends and family will get vaccinated by demographics. Small cells ($n < 30$) are excluded.

S7. Is there an effect of question order (social norms before versus after intentions)?

We manipulated the order of the questions about people's own intentions to get vaccinated and their perceptions of others' intentions in the survey from December 2020. In one condition, respondents rated their perceptions of others' intentions immediately before their own; in another condition, they rated them much later. Although this manipulation cannot show causality (i.e., whether people's own intentions are a consequence of their beliefs about others' intentions or vice versa), it is at least instructive for considering whether one kind of judgment affects another in some transient way. We find no evidence of temporary order effects, however, as multiple regression shows no effect of question order or its interaction with perceived social norms.

<i>Predictor</i>	<i>B</i>	<i>Standard error</i>	<i>Standardized β</i>	<i>t</i>	<i>Sig.</i>
Family/friends perceived	.484	.040	.612	12.151	<.001
Party (Republican)	-.467	.143	-.118	-3.272	.001
Party (Independent)	-.101	.104	-.035	-.971	.332
Race/ethnicity (Black)	-.009	.272	-.001	-.035	.972
Race/ethnicity (Latino)	-.557	.199	-.098	-2.793	.005
Education (No HS)	-.728	.272	-.094	-2.679	.008
Education (HS)	-.290	.126	-.086	-2.294	.022
Education (Some college)	-.086	.124	-.026	-.695	.487
Education (2-year degree)	-.076	.165	-.016	-.459	.646
Gender (Male)	.113	.099	.039	1.136	.257
Age	.000	.003	.005	.139	.890
Question order	.118	.253	.042	.468	.640
Question order x Family/friends perceived	-.022	.053	-.040	-.427	.670

Table S7.1. Multiple regression with question order and its interaction with perceived social norms for family and friends as additional predictors (Study 1).

S8. Is risk perception a plausible confound?

We calculated the odds of providing higher responses of perceived social norms and more vaccination intentions given higher perceptions of the risk of becoming infected with COVID-19 over the next month (0-100% chance). The person who reported higher risk of COVID was slightly more likely to be the person reporting that they would be vaccinated (Estimated $\Delta_{\text{Study}_1} = 1.4$, Estimated $\Delta_{\text{Study}_2} = 1.2$) however this relationship was not strong enough to cross the threshold of substantively changing our statistical inferences about the effect of perceived family/friends vaccination intentions (sensitivity values $\Delta_{\text{Study}_1} = 14.7$, $\Delta_{\text{Study}_2} = 5.9$).⁵ We also learned that the person reporting higher risk of COVID infection was slightly more likely to report perceiving more vaccine positive social norms (calculated Δ_{Study_1} ranged from 1.2 at the lowest (for family) to 1.9 at the highest (for city) and calculated Δ_{Study_2} ranged from .64 (neighbors) to .73 (family)). Again falling short of the lowest sensitivity values required for any variable to change the results (sensitivity $\Delta = 2.2$ for perceptions of city-level norms, Study 2) and lower than values required to change our interpretations of family/friends social norms (sensitivity values of $\Delta_{\text{Study}_1} = 4.5$, $\Delta_{\text{Study}_2} = 3.2$).

We repeated this analysis using a second risk perceptions variable, agreement on a 1 to 5 scale that “Getting vaccinated would put me at risk for vaccine side effects.” The person within a pair who worried least about vaccination side effects was much more likely to report positive intentions in regards to vaccination (Estimated $\Delta_{\text{Study}_1} = 5.5$, Estimated $\Delta_{\text{Study}_2} = 10$). Lack of worry about vaccine side effects also related to perceptions of social norms (Estimated $\Delta_{\text{Study}_1} = 3.7$ (family) to 1.3 (state), Estimated $\Delta_{\text{Study}_2} = 2.3$ (family) to 1.1 (state)). Taken together, these results suggest that perception of risks from COVID vaccination could be a powerful source of confounding in this study, but not powerful enough to drive our results to zero. The family and friends result would require much stronger relationships to overturn the results of study 1 and somewhat stronger bias to overturn the results of study 2: recall for the family/friends result the sensitivity values are $\Delta = 4.5$, $\Delta = 14$ in Study 1; $\Delta = 3.2$, $\Delta = 6$ in Study 2 and we estimate $\Delta = 3.7$, $\Delta = 5.5$ for study 1 and $\Delta = 2.3$, $\Delta = 10$ for study 2.

⁵ We estimated Δ by comparing the numbers of people with the higher own-vaccine intention value within-pair with the numbers of people with the higher COVID risk perception within-pair. This is the odds ratio of the 2x2 table formed by those variables. Confidence intervals for these odds ratios in the Supplementary Material. Code in github.com/thepolicylab/COVID-VaccinesSocialNorms. We estimated Δ the same way, only using higher social norms perceptions as the outcome. Both are quantities interpretable as odds ratios in the sensitivity analysis and so we calculated those odds ratios from the data.

The results that were most sensitive according to the sensitivity analysis also would not produce p -values greater than .05 with confounders like COVID risk perception or COVID vaccination risk perception. We estimated $\Delta = 1.5$ for the effect of COVID risk perceptions and $\Delta = 1.3$ for the effect of COVID vaccination risk perceptions on perceptions of state-level norms in Study 1 and recall that our sensitivity parameters were $\Delta = 2.5$ and $\Delta = 2.6$ (we calculated $\Delta = 5.5$ for COVID vaccination risk perceptions and $\Delta = 1.5$ for COVID risk perceptions for Study 1). Our other most sensitive result, for perceptions of city-level norms in Study 2, required at least $\Delta = 2.2$ and $\Delta = 1.5$ to change our interpretation of our statistical inferences but we found $\Delta = 1.3$ and $\Delta = 10.0$ for COVID vaccination risk perceptions and $\Delta = .7$ and $\Delta = 1.2$ for COVID risk perceptions for Study 2. Recall that both conditions have to hold before the resulting p -value would rise above .05.

Why not match on risk perceptions? A benefit of not including risk perceptions in our design directly was that we could use it to add detail to the sensitivity analysis shown here. This is an observational study, and so must have some confounding or omitted variable bias of some kind whether it arises from factors that we did not anticipate and thus did not observe or factors that we could have imagined and measured a priori. Thus, the grounds on which we should judge whether these results should spur further study and perhaps policy action differ from the grounds on which we judge randomized studies. In this case, the question is not whether we have eliminated all possible confounding. This would be impossible without randomization, and this study did not randomize. However, the key question is whether the existing biases are large enough to overturn the substantive interpretation of our results, namely, that perceptions of the vaccination intentions of others, especially perceptions of personally relevant groups of others like ones family and friends, can play a key role in one's own intentions to vaccinate. What we have shown in this section is that unobserved factors have to be fairly powerful to make such a difference. We then reported on two observed factors that were not included in the research design and showed that, while those variables do relate more or less strongly to both other-perceptions and own-intentions, they do not relate to both strongly enough to overturn the results of the study.

Variable	Odds	Lower CI	Upper CI
Perceived social norms: Family & friends	1.242	0.916	1.686
Perceived social norms: Neighbors	1.352	0.990	1.849

Perceived social norms: City co-residents	1.888	1.369	2.610
Perceived social norms: State co-residents	1.439	1.042	1.990
Own vaccine intentions	1.447	1.025	2.047

Table S8.1. Odds ratios for perceived risk of being infected with COVID-19, Study 1. Entries are odds of the person with higher COVID risk perceptions within a pair having the higher value on the variable (perceptions or intentions). Analysis restricted to pairs that differ on both COVID risk perceptions and value of the other-perceptions or own-intentions variable.

Variable	Odds	Lower CI	Upper CI
Perceived social norms: Family & friends	0.269	0.180	0.397
Perceived social norms: Neighbors	0.588	0.402	0.857
Perceived social norms: City co-residents	0.652	0.441	0.961
Perceived social norms: State co-residents	0.789	0.533	1.166
Own vaccine intentions	0.183	0.116	0.285

Table S8.2. Odds ratios for perceived risk of having severe side effects from the COVID-19 vaccine, Study 1. Entries are odds of the person with higher vaccine side effect risk perceptions within a pair having the higher value on the variable (perceptions or intentions). Analysis restricted to pairs that differ on both risk perceptions and value of the other-perceptions or own-intentions variable.

Variable	Odds	Lower CI	Upper CI
Perceived social norms: Family & friends	0.733	0.543	0.987
Perceived social norms: Neighbors	0.642	0.477	0.864
Perceived social norms: City co-residents	0.692	0.510	0.937
Perceived social norms: State co-residents	0.712	0.526	0.962
Own vaccine intentions	1.198	0.739	1.948

Table S8.3. Odds ratios for perceived risk of being infected with COVID-19, Study 2. Entries are odds of the person with higher COVID risk perceptions within a pair having the higher value on the variable (perceptions or intentions). Analysis restricted to pairs that differ on both COVID risk perceptions and value of the other-perceptions or own-intentions variable.

Variable	Odds	Lower CI	Upper CI
Perceived social norms: Family & friends	0.443	0.313	0.623
Perceived social norms: Neighbors	0.823	0.586	1.157
Perceived social norms: City co-residents	0.758	0.537	1.070
Perceived social norms: State co-residents	0.940	0.664	1.329
Own vaccine intentions	0.100	0.052	0.184

Table S8.4. Odds ratios for perceived risk of having severe side effects from the COVID-19 vaccine, Study 2. Entries are odds of the person with higher vaccine side effect risk perceptions within a pair having the higher value on the variable (perceptions or intentions). Analysis restricted to pairs that differ on both risk perceptions and value of the other-perceptions or own-intentions variable.

S9. Excluding repeat respondents

YouGov recruits US survey respondents from a large pool, but the subset of Rhode Islanders is comparatively small given the size of the state. As a result, some individuals who responded to the surveys used for Study 1 appeared in both the November and December samples. The analysis reported in the main paper excludes the second occurrence of any repeat respondent, but we also ran the analyses excluding first occurrences as a robustness check. This alternate matched design placed 786 respondents into 393 pairs. The balance test again suggested that the covariate-to-perceptions relationship was consistent with what we would expect from a pair-randomized experiment, $\chi^2(8) = 9.7, p = .29$.⁶ The null of no average effect is easily rejected for all four others groups (all p values $< .001$, two-tailed), and the estimates again decline systematically (friends and family = .35, neighbors = .31, people in city or town = .28, people in state = .22). In summary, the pattern of results is the same.

⁶ Note that this balance test has one more degree of freedom than in our main analysis. This is because while we did not *require* that the two members of each pair share a trust in science response, it happened to be that the resulting match had this property. However, this serendipity did not occur for this robustness test.

S10. Are vaccination social norm perceptions associated with differences in other COVID mitigation measures?

We also compared perceived social norms of COVID testing and mask-wearing with respondents' own reported behaviors, although these social norms were queried only for respondents' family and friends. Using the same matched design from Study 1, we regressed respondents' reported intentions to get tested in the near term ("Do you intend to go out and get a coronavirus test in the next 2 weeks?"; 1 = *Definitely won't*, 2 = *Probably won't*, 3 = *I might not*, 4 = *I might*, 5 = *Probably will*, 6 = *Yes, definitely*) on the proportion of their friends and family they believe plan to get tested ("How many of your friends and family members do you think intend to be tested for coronavirus?"; 1 = *None*, 2 = *A few (less than a quarter)*, 3 = *About a quarter*, 4 = *About half*, 5 = *About three quarters*, 6 = *Most (more than three quarters)*, 7 = *All*), conditional on pair. The testing intention difference related to a one-point difference between perceived social norms among friends and family is .29, $p < .001$. A difference for masking was also evident, .93, $p < .001$. In summary, beliefs about behaviors of close social ties are strongly related to people's own behaviors for other COVID-19 mitigation measures.

S11. Demographics of the matched samples

Variable	Study	Category							
		<i>Male</i>	<i>Female</i>	<i>Other</i>	<i>Prefer not to say</i>				
Gender	1	42.4%	56.8%	0.5%	0.4%				
	2	43.8%	54.8%	1.1%	0.3%				
		<i>White</i>	<i>Black</i>	<i>Hispanic</i>	<i>Asian</i>	<i>Native American</i>	<i>Mixed</i>	<i>Other</i>	<i>Middle Eastern</i>
Race	1	89.1%	3.9%	4.9%	1.1%	0.2%	0.2%	0.5%	0.1%
	2	86.7%	6.0%	3.4%	1.2%	0.3%	1.4%	0.8%	0.1%
		<i>18-29</i>	<i>30-39</i>	<i>40-49</i>	<i>50-59</i>	<i>60-69</i>	<i>70+</i>		
Age range	1	17.6%	16.6%	13.6%	20.0%	19.5%	12.6%		
	2	14.0%	18.2%	14.0%	19.2%	19.5%	15.3%		
		<i>No HS</i>	<i>HS graduate</i>	<i>Some college</i>	<i>2-year degree</i>	<i>4-year degree</i>	<i>Post-grad degree</i>		
Education	1	2.3%	25.0%	23.1%	12.7%	23.3%	13.6%		
	2	2.9%	24.7%	21.8%	14.1%	23.8%	12.8%		
		<i><10,000-19,000</i>	<i>20,000-39,000</i>	<i>40,000-59,000</i>	<i>60,000-79,000</i>	<i>80,000-99,000</i>	<i>100,000-119,000</i>	<i>120,000-149,000</i>	<i>>150,000</i>
Family income	1	13.9%	20.7%	17.5%	19.5%	9.2%	8.1%	5.9%	5.4%
	2	16.6%	21.5%	17.5%	16.2%	9.6%	6.5%	5.6%	6.5%
		<i>Democrat</i>	<i>Republican</i>	<i>Independent</i>	<i>Other</i>	<i>Not sure</i>			
Party ID	1	39.8%	16.3%	34.2%	3.9%	5.8%			
	2	36.7%	20.5%	32.8%	3.6%	6.3%			
		<i>Very liberal</i>	<i>Liberal</i>	<i>Moderate</i>	<i>Conservative</i>	<i>Very conservative</i>	<i>Not sure</i>		
Political ideology	1	13.2%	22.1%	32.9%	18.8%	5.9%	7.0%		
	2	14.3%	20.3%	31.9%	17.2%	7.9%	8.4%		
		<i>Definitely won't</i>	<i>Maybe won't</i>	<i>Not sure</i>	<i>Maybe will</i>	<i>Definitely will</i>	<i>Vaccinated</i>		
Vaccination intentions	1	10.6%	5.8%	20.1%	23.9%	39.6%	n/a		
	2	11.0%	4.2%	10.2%	8.2%	25.7%	40.6%		