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Beliefs about social norms and (the polarization of) COVID-19 vaccination readiness*

Silvia Angerer, Daniela Glätzle-Rützler, Philipp Lergetporer, and Thomas Rittmannsberger†

Abstract

Social norms affect a wide range of behaviors in society. We conducted a representative experiment to study how beliefs about the existing social norm regarding COVID-19 vaccination affect vaccination readiness. Beliefs about the norm are on average downward biased, and widely dispersed. Randomly providing information about the existing descriptive norm succeeds in correcting biased beliefs, thereby reducing belief dispersion. The information has no effect on vaccination readiness on average, which is due to opposite effects among women (positive) and men (negative). Fundamental differences in how women and men process the same information are likely the cause for these contrasting information effects. Control-group vaccination intentions are lower among women than men, so the information reduces polarization by gender. Additionally, the information reduces gendered polarization in policy preferences related to COVID-19 vaccination.

Keywords: social norms, vaccination, COVID-19
JEL classification: C93, D90, I12

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1. Introduction

In addition to immeasurable human suffering, the COVID-19 pandemic led to a severe economic downturn in the global economy.[1] High vaccination coverage is critical for sustained containment of the COVID-19 pandemic (WHO, 2022). While global vaccine supply has accelerated to current high levels by the end of 2021, vaccination has become a highly polarizing public issue. In fact, many countries struggle with the refusal of COVID-19 vaccination among significant portions of their populations. For instance, in Germany, the country we study, only 76% of the population received basic immunization (two vaccinations) by December 2022.[2]

A potentially effective means of promoting vaccination readiness is to rely on social norms. Social norms – the informal rules that we live by (Bicchieri et al., 2022a) – influence virtually all aspects of human behavior and have thus attracted considerable interest in the social sciences (e.g., Cialdini et al., 1991; Ostrom, 2000; Bicchieri, 2005). They are key to facilitating economic transactions by sustaining cooperation among strangers, especially when there are individual incentives for free-riding (e.g., Fehr & Fischbacher, 2004; Fehr & Gächter, 2000).[3] Vaccination decisions may be susceptible to the free-rider problem because the public-good nature of vaccination provides an incentive for individuals to rely on others to get vaccinated rather than to get vaccinated themselves (Agranov et al., 2021). In this paper, we investigate how social norms affect individuals' COVID-19 vaccination readiness.

Specifically, we study how providing factual information about the existing social norm regarding COVID-19 vaccination – a "norm-nudge" (Bicchieri & Dimant, 2022) – affects individuals' vaccination readiness. Information interventions such as ours are based on the assumption that significant segments of the population hold biased beliefs about the prevailing social norm (e.g., Cantoni et al., 2019; Bursztyn et al., 2020). As we show, this is the case with COVID-19 vaccination, likely because people had not yet fully internalized the new social norms regarding COVID-19 containment measures that were dynamically evolving at the onset of the pandemic (Hensel et al., 2022).[4]

To this end, we conducted an information provision experiment involving two consecutive online surveys with different samples representative of the German adult population ($N = 2,030$ in the first survey and $N = 3,045$ in the second survey). The surveys were conducted between March and April 2021, at a time when large shares of the population were still unvaccinated. The purpose of the first survey was to measure social norms regarding COVID-19 vaccination. We asked respondents about their intention to vaccinate (i.e., the *descriptive norm*) as well as their normative opinion about whether

[1] Compared to 2019, global GDP contracted by approximately 6.7% in 2020 (Szmigiera, 2022).

[2] See https://impfdashboard.de/; accessed 2 December 2022.

[3] Social norms affect behavior in a wide range of economically relevant domains, such as labor supply and job search decisions (Bertrand et al., 2016; Bursztyn et al., 2020; Grewenig et al., 2020; Stutzer & Lalive, 2004), altruistic giving (Andreoni & Bernheim, 2009; Andreoni et al., 2017; Dellavigna et al., 2012), political engagement (Cantoni et al., 2019; Dellavigna et al., 2017; Enikolopov et al., 2020; Gerber et al., 2008; Perez-Truglia & Cruces, 2017), school choice (Bursztyn & Jensen, 2015), or energy consumption (Allcott, 2011).

[4] While, social norms usually persist fairly unchanged over long periods (Alesina et al., 2013; Algan & Cahuc, 2010; Andreoni et al., 2017; Fernández, 2007; Giuliano, 2007; Voigtländer & Voth, 2012), they can change quickly in response to major events in society, like surprising election outcomes (Bursztyn et al., 2020) or the outbreak of a pandemic. Bursztyn & Yang (2022) show that people frequently misperceive social norms.

people should get vaccinated (i.e., the *injunctive norm*).[5] Both norm measures are highly congruent. The information experiment was implemented in the second survey, in which respondents were randomly assigned to the ***Norm Info*** treatment group or the control group. Respondents in the ***Norm Info*** group were informed about the descriptive norm (i.e., the share of people who intended to vaccinate against COVID-19 measured in the first survey) before answering the same outcome questions as the uninformed control group.[6] Our primary outcome of interest is respondents' vaccination readiness, which we measured using a total of seven survey items. Beyond non-incentivized survey questions, the items also include a revealed-preference measure in which respondents could request a link to pre-register for a COVID-19 vaccination. Additional post-treatment outcomes include respondents' posterior beliefs about the social norm, opinions and beliefs about COVID-19 vaccination as potential mediators, and policy preferences regarding COVID-19 vaccination (e.g., introducing mandatory vaccination). To gauge information status at baseline, we also elicited all respondents' prior beliefs about the descriptive norm regarding COVID-19 vaccination before the information treatment.

We find that respondents hold downward biased beliefs about the existing norm: While they on average think that only 62% intend to get vaccinated, the actual share is 70%. Consistent with the notion that COVID-19 vaccination is a polarizing issue, prior beliefs about the social norm are highly dispersed, with a 10-90 percentile range between 40% and 80%. Furthermore, respondents' beliefs about the descriptive norm are highly correlated with their vaccination readiness. Our randomized experiment aims to determine whether this association reflects the causal effect of beliefs about the norm.[7]

Next, we turn to the causal effects of providing information about the descriptive norm. The ***Norm Info*** treatment induces belief updating: It upwardly corrects respondents' downward biased average beliefs about the share of people who intend to get vaccinated, and also substantially reduces the dispersion of posterior beliefs (from a 10-90 percentile range of 45%-85% to 60%-80%). Distinguishing between respondents by their prior beliefs, the treatment significantly increases the beliefs of those who initially underestimated the norm, significantly decreases the beliefs of those who overestimated it, and does not affect those with correct prior beliefs.[8] In contrast to the strong information effects on respondents' beliefs, the ***Norm Info*** treatment does not affect respondents' average vaccination readiness. We find precisely estimated null effects on all items measuring vaccination readiness when we consider the entire sample, or when we distinguish between respondents according to their prior beliefs about the descriptive norm.

Consistent with the notion that women are more sensitive to social cues than men (e.g., Croson & Gneezy, 2009), we find that the overall null effect on vaccination readiness is due to opposing and highly significant effects on the vaccination readiness of women and men. While the norm information

[5] According to the existing literature, a descriptive norm tells us what people actually do, while an injunctive norm tells what behavior people approve or disapprove (Benabou & Tirole, 2011; Cialdini et al., 1991). Bicchieri & Dimant (2022) provide a taxonomy of behavior which differentiates between behavior based on "customs" (independent from others' behavior and approval), "descriptive norms" (dependent on others' behavior, independent from others' approval), "moral rules" (dependent on others' behavior, independent from others' approval), and "social norms" (dependent on others' behavior and approval).

[6] We chose to use the descriptive norm in the information treatment because this type of norm is the primary driver of norm conformity (Bicchieri & Xiao, 2009, see Section 2.2.1).

[7] The correlation between norm beliefs and vaccination readiness may also be due to other factors, such as reverse causality in the sense that vaccination readiness influences beliefs (e.g., because of projection bias or motivated reasoning; see Bursztyn & Yang (2022)).

[8] In line with the high congruence between the descriptive and injunctive norm, information effects on beliefs about the injunctive norm are almost identical.

increases vaccination readiness of women, it *decreases* the one of men. For both genders, the treatment effect is driven by those who initially underestimated the descriptive norm to vaccinate. This heterogeneous response to the social norm information by gender is particularly relevant given the societal polarization regarding COVID-19 vaccination: In line with previous research, women are less likely to intend getting vaccinated compared to men in the control group, implying that the treatment reduces polarization of vaccination readiness across genders.

Using rich information on potential mediators, we uncover reasons why information about the descriptive norm has differential effects on the vaccination readiness of women and men. Both genders differ fundamentally in how they process the norm information provided: For women, the treatment increases their normative opinions about COVID-19 vaccination, their beliefs about vaccination behavior, and expectations of their reference network (i.e., their relatives and friends), their beliefs about vaccine efficacy, and decreases their free-riding behavior with respect to COVID-19 vaccination. The effects for men go in exactly the opposite direction. Conducting a mediation analysis, we show that these channels can explain most of the differential ***Norm Info*** effect on women and men.

Finally, we show that the norm information also has opposite effects on policy preferences related to COVID-19 vaccination: while the treatment decreases men's preferences for measures like making vaccination mandatory or punishing vaccine refusers, effects for women go in the opposite direction. Since women are more opposed to these measures than men in the control group, treatment ***Norm Info*** also contributes to reducing polarization in people's policy preferences.

We contribute to several strands of the literature. First, we add to the literature on COVID-19 vaccination intentions and behavior. Descriptive studies have shown that vaccination intentions correlate with factors such as the perceived risk of COVID-19, perceived vaccine efficacy, or political attitudes (see Wake, 2021, for a review). Previous experimental studies have investigated the causal effects of, for example, defaults, incentives (Serra-Garcia & Szech, 2022; Campos-Mercade et al., 2021; Klüver et al., 2021; Sprengholz et al., 2021), reminders (Dai et al., 2021), communication and framing (Petersen et al., 2021; Sudharsanan et al., 2021), the vaccine approval procedure (Angerer et al., 2022b), or the desire to influence others (Esguerra et al., 2022) on vaccination intentions and behavior.[9] Focusing on social norms as we do, correlational evidence shows that normative beliefs are closely associated with adherence to COVID-19 containment measures in general (e.g., Hensel et al., 2022), and with vaccination intentions in particular (e.g., Jaffe et al., 2022; Collis et al., 2022; Rabb et al., 2022). However, experimental evidence on the causal effects of social norms on COVID-19 vaccination intentions is scant. We thus contribute to the literature on the determinants of COVID-19 vaccination readiness by providing causal evidence on how social norms affect vaccination readiness.

Closest to our paper, Moehring et al. (2021) conducted a survey experiment in several countries, and find that, on average, the effect of norm information on vaccination intentions is positive, but varies widely across countries. Consistent with our results, they find a null effect for Germany. Our study adds to these findings in several key dimensions: First and foremost, we demonstrate that the overall null effect

[9] Most of the literature relies on survey-measured self-reported vaccination intentions as outcomes of interest (exceptions that focus on actual vaccination rates include Campos-Mercade et al. (2021) and Dai et al. (2021)). Reassuringly, we show that the effects of our information treatment on non-incentivized survey measures of vaccination readiness are very similar to the effects on the revealed-preference measure of requesting, and clicking on a link to pre-register for COVID-19 vaccination.

is driven by opposing significant effects on women and men. In addition, we measured respondents' posterior beliefs and possible mediators after the treatment, and can therefore show that the differential information effects for women and men are due to gender differences in information processing.

Second, we contribute to the literature that examines the effects of social norms on behavior in a variety of economically relevant domains, from education and labor supply to political engagement and altruistic giving (see references in footnote 3). On the one hand, we add to this body of evidence by showing that information about the descriptive social norm influences COVID-19 vaccination readiness, a very important and socially polarized behavioral domain for virus containment. On the other hand, we contribute to the literature on social norms, which argues that information about descriptive norms can have opposite effects on targeted behavior (Schram et al., 2022). We show that information about the descriptive norm can increase socially desirable behavior — what Schram et al. (2022) call "conformism effect" — in one subgroup (women) while decreasing it in the other subgroup (men) – what is called "contagion effect". Intriguingly, these opposing effects are not due to differences in prior beliefs about the prevailing norm, since both groups' treatment effects are driven by individuals who underestimated the descriptive norm to vaccinate. Rather, women and men differ fundamentally in how they process the information provided, which explains differential effects on vaccination readiness. Thus, our results suggest that accounting for channels beyond belief updating through which descriptive norm information can influence behavior (e.g., normative opinions, beliefs about the reference network, beliefs about the efficacy of the targeted behavior, or free-riding considerations) is necessary to make directional predictions about how norm-nudge interventions influence behavior.

Finally, we contribute to the literature on gender differences and polarization in economic behavior (Croson & Gneezy, 2009). Women have been shown to be more concerned about COVID-19, and more compliant with containment measures. However, they are also more reluctant to vaccinate against COVID-19 – a pattern referred to as the "COVID-19 vaccine's gender paradox" (Galasso et al., 2021). Our findings that information about the descriptive norm increases (decreases) women's (men's) vaccination readiness and related policy preferences imply that social norms can be an effective tool to mitigate societal polarization along the gender dimension. Additionally, we add to the literature that has shown that women are more receptive to social cues than men (e.g., DellaVigna et al., 2013) by uncovering some of the mechanisms behind the gendered response to social norm information.

The rest of the paper is structured as follows. Section 2 describes our data and experimental design. Section 3 present our results, and Section 4 concludes.

2. Data and Experimental Design

2.1. Data Collection and Sample

We conducted two consecutive online surveys with two different samples of a total of 5,075 adults (18-69 years) in Germany (2,030 in the first survey and 3,045 in the second survey).[10] The samples were drawn from an online access panel by the polling institute Respondi in such a way that they match the official population statistics in terms of age, gender, educational attainment, and federal state of residence.[11] The surveys were conducted between 24 March and 22 April 2021, at a time when large parts of the population had not yet been vaccinated and vaccines were in short supply (see Appendix B for information on vaccination rollout and polling details).

The objective of the first survey (conducted 24 March - 2 April 2021) was to obtain a quantitative measure of the social norm regarding COVID-19 vaccination. We elicited individuals' intention to vaccinate (ITV), which, when aggregated, serves as our measure of the *descriptive norm*. Specifically, we elicited agreement with the statement "*I will get vaccinated against COVID-19 as soon as a vaccine is available for me*" on a 5-point Likert scale ranging from "*I fully agree*", "*I rather agree*", "*Neither nor*", "*I rather disagree*", to "*I fully disagree*" (see Appendix Table A1 for exact question wording). We use the answers to this question in our information experiment. In addition, we elicited normative opinions about COVID-19 vaccination from the same individuals (agreement with the statement "*People should get vaccinated against COVID-19 as soon as a vaccine is available*"), which, when aggregated, represent the *injunctive norm*. Below, we show that both types of norms are highly congruent (see Section 2.2.1).

The information experiment was implemented in the second survey (conducted 8 - 21 April 2021). It included a series of questions about COVID-19 vaccination, including a measure of revealed preference (see Section 2.2.3). We also collected detailed sociodemographic background information and measured survey inattention. Table 1 presents the observable characteristics of our analytical sample (control group).

2.2. Experimental Design

In this section, we first present our information treatment and then describe how we measured beliefs about the descriptive norm regarding COVID-19 vaccination, and vaccination readiness.

[10] We consider the under-70 age group to be particularly relevant for our research question for at least two reasons: First, vaccination hesitancy is much more pronounced among relatively younger compared to older individuals (see e.g., Robinson et al., 2021, for a review). Second, at the start of the first (second) survey, the share vaccinated was much higher among those aged 70 and older, at 28% (37%), compared with only 6% (8%) among those younger than 70 (Timcke et al., 2021), limiting the scope for norm nudges to affect vaccination readiness in the older age groups.

[11] Reassuringly, Grewenig et al. (2018) show that online samples drawn to match population characteristics, such as ours, represent the entire population well. Furthermore, Peyton et al. (2021) show that online experiments conducted before the COVID-19 pandemic could be well replicated during the pandemic, demonstrating that the pandemic does not compromise the generalizability of online experiments.

Table 1: Summary statistics and balancing tests

	Experimental group			Experimental group	
	Control	***Norm Info*** (difference)		***Control***	***Norm Info*** (difference)
Sociodemographics					
Female	0.50	-0.007	**COVID-19**		
Age in Years	44.96	0.146	Already vaccinated	0.13	0.032**
Born in Germany	0.93	0.012	Already had COVID-19	0.06	-0.004
Living in the East of Germany	0.18	0.024*	Risk group	0.39	-0.016
Equivalized household size	1.59	0.000	Contact to risk group	0.36	-0.004
Equivalized household income [in Euros]	1,694	6.39	**Economic preferences**		
University degree	0.10	0.006	Risk-taking	4.04	0.014
Highest school degree			Patience	6.88	-0.040
No degree/basic degree	0.27	0.002	Altruism	7.41	-0.002
Middle school degree	0.34	-0.018	Trust in other people	2.46	0.009
University entrance qualification	0.38	0.016	Trust in government	2.03	0.034
Work status			Trust in science	2.85	0.012
Currently working	0.61	-0.019			
Working in health sector	0.08	0.003	**Non-response**	0.00	0.008***
Working in system-relevant job	0.16	0.014			
Political party preferences					
AfD§	0.08	0.010			
CDU / CSU§	0.22	-0.020			
FDP§	0.07	0.002			
SPD	0.13	0.007			
Die Gruenen	0.15	0.016			
Linke	0.08	0.005			
Other	0.03	-0.001			
None	0.24	-0.019			
Observations	1509	1536			

Note: Columns ***Control*** show mean values in the control group. Columns ***Norm Info*** shows the difference in means to the treatment group. **Equivalized household size** is a measure of household size using a standard (equivalence) scale, the modified OECD scale, which gives a weight of 1 to the first adult in the household, 0.5 to each other person in the household aged 14 years or older, and 0.3 to each child under the age of 14. **Equivalized household income** corresponds to the reported household income divided by the equalized household size. **Currently working** is *one* if respondents report being (self-)employed. Political party preference was elicited by asking which party respondents generally sympathize with. **Already vaccinated** indicates whether the respondent already received the first dose of some COVID-19 vaccine. **Risk group** indicates whether respondents perceive themselves as being at increased risk for a severe disease progression due to a COVID-19 infection. **Risk-taking**, **Patience**, and **Altruism** were measured on 11-point Likert scales following Falk et al. (2018). **Trust** was measured using a 4-point Likert scale ranging from 1 "no trust at all" to 4 very high trust". Non-response takes the value 1 if respondents did not answer at least one of our six main outcome variables.

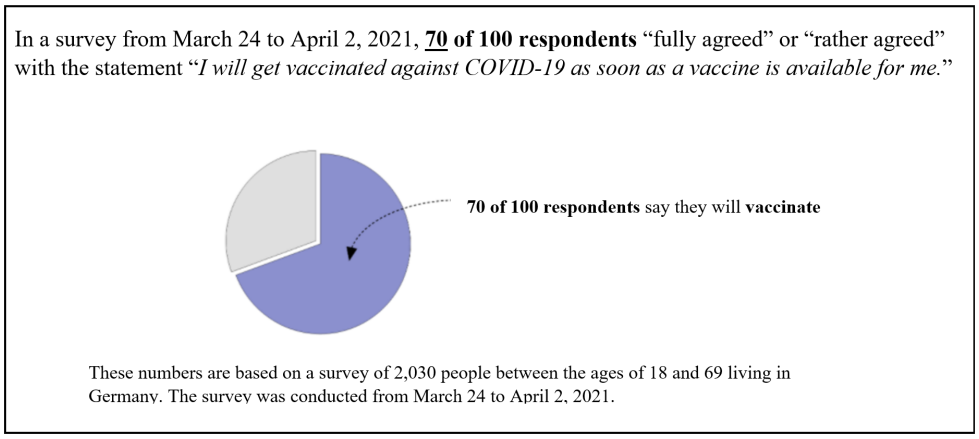
§ Leaning towards any of these political parties is classified as conservative political orientation

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

2.2.1. Information Treatment

We use the information on the descriptive norm — the share of other people who intend to get vaccinated against COVID-19 that we collected in the first survey — in our information treatment. The literature distinguishes between two types of norms: descriptive norms (what most others do) and injunctive norms (what most others approve or disapprove of) (Cialdini et al., 1991). For an individual to conform to a social norm, she must believe that a sufficiently large share of the (relevant) population (i) follows the norm (i.e., beliefs about the descriptive norm) and (ii) expects her to follow the norm (i.e., beliefs about the injunctive norm) (Bicchieri, 2005). If the descriptive norm and the injunctive norm are incongruent, the descriptive norm is the primary driving force of norm conformity (Bicchieri & Xiao, 2009). For the case of COVID-19 vaccination, Jaffe et al. (2022) shows that the descriptive norm is a stronger predictor for vaccination intentions than the injunctive norm in a sample of U.S. college students.

Figure 1: Screenshot of the provided information to respondents in ***Norm Info***



Note: After eliciting respondents' prior beliefs about the *descriptive norm*, we informed those in ***Norm Info*** group about the correct norm. The upper part presents the following information, and the lower part shows a graphical depiction of it. Additionally, the screen included information about the sample size, the age range of respondents, and when the survey was conducted.

The descriptive and the injunctive norm collected in the first survey are highly congruent: 70% of the respondents agree ("fully agree" or "rather agree") that they will get vaccinated (descriptive norm), and the same share of 70% agree that people should get vaccinated (injunctive norm). Both norms are highly correlated ($\rho = 0.88$). Our figures are very similar to those obtained in other surveys in Germany at the time (e.g., Betsch et al., 2021).

In the experiment implemented in the second survey, respondents were randomly assigned to either the treatment group ***Norm Info*** or the control group. Respondents in the ***Norm Info*** group received information about the descriptive norm before answering the same outcome questions about COVID-19 vaccination as respondents in the control group, who received no information. Figure 1 shows the information screen displayed to the ***Norm Info*** group. The lower part of the screen shows a graphical depiction of the information. The upper part presents the following information: "...70 of 100 respondents "fully agreed" or "rather agreed" with the statement "*I will get vaccinated against COVID-19 as soon as a vaccine is available for me*".[12] In addition, the screen included information about the sample size, the age range of respondents, and when the survey was conducted.

2.2.2. Eliciting Prior and Posterior Beliefs about the Social Norm

At the beginning of the second survey, before the randomized information experiment, we elicited respondents' *prior* beliefs about the descriptive norm.[13] Specifically, we showed them a screenshot of the corresponding question from the first survey and asked, "*What percentage of respondents do you guess agrees with the following statement?*" Respondents indicated how many out of 100 they thought agreed "*fully*" or "*rather*". To differentiate between confidently held false beliefs (*misinformation*) and random

[12] The information from the upper part of the screen was also shown to treated respondents when answering post-treatment outcome questions to avoid recall bias.

[13] We refrained from providing monetary incentives for belief accuracy because incentivizing beliefs in online surveys can induce reporting bias (Grewenig et al., 2022). In addition, Danz et al. (2022) show that informing respondents that there are incentives for correct beliefs can lead to deviations from truthful reporting.

guesses (*uninformedness*) (Kuklinski et al., 2000), we also asked how confident respondents were that their answer was correct (on a 7-point scale from 1 "*very unsure*" to 7 "*very sure*").

Because we are interested in how information affects respondents' beliefs, we also elicited their *posterior* beliefs about the descriptive and injunctive norm after the randomized information treatment. To avoid confusing respondents by asking them the exact same question twice, we have slightly modified the *posterior* belief question about the descriptive norm so that it refers to the German population in general (and not to respondents in the first survey as in the question on prior beliefs): "*What percentage of the adult population in Germany do you guess agrees with the following statement?*".

2.2.3. Post-treatment Outcomes: Vaccination Readiness, Mediators, and Policy Preferences

After randomly providing information about the descriptive norm regarding COVID-19 vaccination,we collected two sets of outcomes. The first set is our primary outcomes, which capture various dimensions of vaccination readiness. The second set includes possible mediators through which the information treatment may operate, as well as preferences for policies to increase vaccination rates.

Vaccination readiness. We used a total of seven survey items to measure respondents' vaccination readiness. First, we elicited agreement with the following statements about respondents' intention to vaccinate (ITV) on a 5-point Likert scale: (1) "*I will get vaccinated against COVID-19 as soon as a vaccine is available for me.*" [ITV overall]; (2) "*If I could choose the vaccine myself, I would get vaccinated against COVID-19 as soon as a vaccine is available for me.*" [ITV vaccine of choice]; (3) "*If I had the opportunity, I would get vaccinated tomorrow with the AstraZeneca vaccine.*" [ITV AstraZeneca]; (4) "*If I had the opportunity, I would get vaccinated tomorrow with the BioNTech/Pfizer vaccine.*" [ITV BioNTech].[14] We also asked respondents (5) if they would like to receive a link to pre-registration for COVID-19 vaccination at the end of the survey, to which they could answer "yes" or "no" (similar to Esguerra et al. (2022)). [Link to pre-registration]. We include this revealed-preference measure because non-incentivized survey responses like ours (which are standard in the literature) are sometimes criticized for having no immediate economic consequences for the respondent (e.g., Carson, 2012; Kling et al., 2012). Finally, we measured respondents' (6) willingness to pay for their own vaccination [WTP me], and (7) for the vaccination of a person of their choice [WTP other].

As pre-registered, we combine answers to individual questions to create two summary indices: an index for the intention to vaccinate [**ITV Index**], which is composed of items (1)-(5), and an index for the willingness to pay [**WTP Index**] which is composed of items (6)-(7).[15] The advantage of using summary indices is their robustness to overtesting, and that they have less measurement error compared to the individual items (e.g., Anderson, 2008). Appendix Table A2 shows that the seven items are highly

[14] At the time of our survey, there were some cases of blood clots associated with AstraZeneca's vaccine, leading to some skepticism about the safety of the viral vector vaccine. In fact, Steinert et al. (2021) document lower intentions to vaccinate in Germany for viral vector vaccines than for mRNA vaccines such as BioNTech/Pfizer's. Therefore, we elicited ITV for both AstraZeneca's and BioNTech/Pfizer's vaccines.

[15] We computed the **ITV Index** by first dichotomizing items (1)-(4) (one = "*I fully agree*" or "*I rather agree*", zero else), and then taking the arithmetic mean of these four items and item (5) (link to pre-registration; one = "yes", zero = "no"). We dichotomize the outcome variables measured on the 5-point scale to facilitate interpretation, but all results also hold without dichotomization (results available upon request). We computed the **WTP Index** by first winsorizing the individual WTP items (6) and (7) at the 99th percentile and then taking the arithmetic mean.

correlated with each other and also with the probability of actually clicking the pre-registration link at the end of the survey [Click on link]. While we use these indices in our main analysis, we show that results are robust when considering the individual items separately.

Mediators. We elicited the following likely mediators through which information about the descriptive norm might affect vaccination readiness: 1) normative opinions about COVID-19 vaccination (which in aggregate make up the injunctive norm), 2) beliefs about the vaccination behavior and expectations of the respondents' reference network, 3) beliefs about vaccine efficacy, and 4) effects of others' behavior on respondents' vaccination decision. The question wordings are shown in Panel A of Appendix Table A3.[16]

Policy preferences. Policies to increase vaccination rates – such as making vaccination mandatory or giving vaccinated people more freedom — were at the center of political discourse in the early months of the vaccination campaign. We elicited respondents' preferences for such policies to examine how they are affected by information about the descriptive norm regarding COVID-19 vaccination (see Panel B of Appendix Table A3 for question wordings).

2.3. Econometric model and test of randomization

Given the random assignment of respondents to the experimental groups (***Norm Info*** and control group), we can use the following simple regression model to estimate the causal effect of the information treatment:

$$y_i = \alpha_0 + \alpha_1 NormInfo_i + \delta X_i + \epsilon_i \tag{1}$$

where y_i is the outcome of interest for individual i, $NormInfo_i$ is the binary information treatment indicator, X_i is a vector of control variables, and ϵ_i is an error term. The average treatment effect of providing information about the descriptive norm, α_1, is identified because of the random assignment of treatment status. Therefore, adding control variables should not alter treatment-effect estimates, though it might increase precision. Thus, we present estimation results with and without additional covariates. In our analysis, we focus on the 87% of respondents who have not yet been vaccinated, as this is the relevant group for studying vaccination readiness. All qualitative results hold when vaccinated respondents are included in the analysis (results available upon request). [17]

To analyze heterogeneous treatment effects across subgroups, defined e.g., over respondents' prior beliefs of the descriptive norm or sociodemographic characteristics, we extend our basic regression model to:

$$y_i = \beta_0 + \beta_1 NormInfo_i + \beta_2 Subgroup_{ki} + \beta_3 NormInfo_i \times Subgroup_{ki} + \delta X_i + \epsilon_i \tag{2}$$

[16] Our selection of possible mediators is consistent with the literature which discusses possible mechanisms for how information about descriptive norms may influence behavior (e.g., Bicchieri & Dimant, 2022).

[17] Vaccinated respondents were asked to put themselves in the situation as if they were not yet vaccinated when answering the survey.

where $Subgroup_{ki}$ equals *one* if respondent i is a member of the respective subgroup k, and *zero* otherwise. The treatment effect for non-members is given by β_1, and β_3 measures the additional treatment effect for subgroup members.

Test of randomization. To test whether randomization successfully balanced the characteristics of the respondents in both experimental groups, we examine whether our rich set of covariates differs by treatment status. Columns ***Control*** of Table 1 depict the mean values of the observable characteristics in the control group. Columns ***Norm Info*** report the coefficients γ_1 of regressions of the form:

$$C_i = \gamma_0 + \gamma_1 NormInfo_i + \epsilon_i \tag{3}$$

for each observable characteristic C_i. It is reassuring that only 3 out of 34 comparisons yield a significant coefficient at the 5 percent level. Hence, it seems that the random assignment worked as intended.

3. Results

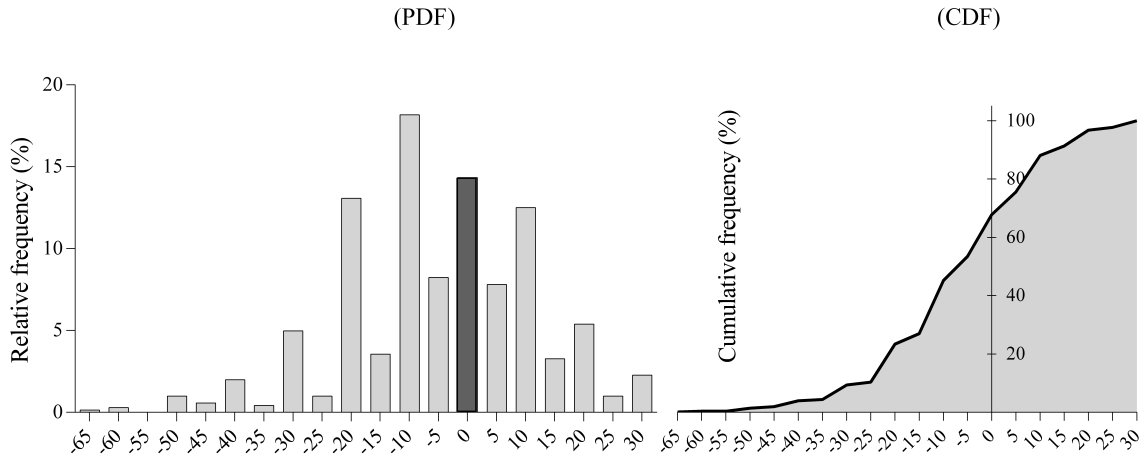
We present our results in three steps. First, we show descriptive analyses of the distribution of prior beliefs about the norm and how they relate to vaccination readiness. Second, we estimate the effects of randomly providing information about the norm on posterior beliefs and vaccination readiness in the overall sample. Third, we study information effects separately for women and men and explore the mechanisms behind the opposite effects on both groups' vaccination readiness.

3.1. Descriptive Evidence

We start by describing respondents' prior beliefs about the descriptive norm. Beliefs are downward biased: On average, respondents believe that 62% intend to get vaccinated, which is 8 percentage points lower than the actual 70% of people who intend to get vaccinated. Moreover, beliefs are highly dispersed, with a 10-90 percentile range between 40% and 80%. Figure 2 presents distributions of respondents' "wedge" between prior beliefs and the actual descriptive norm (prior belief minus 70 percentage points). The probability mass is concentrated to the left of zero, showing that the majority of respondents (58%) underestimate the descriptive norm, 28% overestimate it, and 14% hold correct prior beliefs.

Beliefs about the descriptive norm are closely related to respondents' vaccination readiness. Regressing our nine measures of vaccination readiness (7 individual items and 2 indices) on prior beliefs in Table 2, we find positive and highly significant relationships in every single regression without and with additional covariates. The fact that (i) beliefs about the descriptive norm are downward biased, and (ii) that these beliefs are strongly related to vaccination readiness suggests substantial scope for providing information to increase vaccination readiness. Note, however, the strong associations between beliefs and vaccination readiness do not necessarily reflect a causal effect of beliefs. It may also be that causality is reversed, such that vaccination readiness influences beliefs about the social norm (e.g., through projection bias or motivated reasoning; see Bursztyn & Yang (2022)), or that the relationship is due to

Figure 2: Distribution of the "wedge" between prior beliefs and the descriptive norm



Note: Left (PDF): Relative frequency distribution of the "wedge" between respondents' prior beliefs about the descriptive norm and the actual descriptive norm (calculated as stated belief minus 70 percentage points). Right (CDF): Cumulative frequency distribution of the "wedge".

omitted variable bias. Therefore, we next study how the random provision of information about the descriptive norm in our experiment causally affects vaccination readiness.

Table 2: Association between norm beliefs and vaccination readiness

	ITV Index		ITV Overall		ITV Vaccine of Choice		ITV Astra Zeneca		ITV BioNTech		Link to pre-registration	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Belief: Descriptive Norm	0.007***	0.004***	0.009***	0.006***	0.006***	0.004***	0.006***	0.003***	0.007***	0.004***	0.007***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Covariates		✓		✓		✓		✓		✓		✓

	WTP Index		WTP Me		WTP Other	
	(13)	(14)	(15)	(16)	(17)	(18)
Belief: Descriptive Norm	0.493***	0.259***	0.477***	0.249***	0.509***	0.269***
	(0.075)	(0.059)	(0.072)	(0.057)	(0.084)	(0.066)
Covariates		✓		✓		✓

Note: OLS regressions. **Independent variable**: beliefs about the descriptive norm to vaccinate. Dependent variables: see description in Section 2.2.3. Covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3.2. Average Effects of providing Information on Beliefs and Vaccination Readiness

A necessary condition for information about the descriptive norm to affect vaccination readiness is that it successfully corrects respondents' biased beliefs. Columns 1 and 2 of Table 3 show the results of regressing beliefs about the descriptive norm on the ***Norm Info*** treatment indicator. Odd-numbered

columns do not include covariates, whereas even-numbered columns include basic covariates, as indicated in the table notes.

We find that the information induces belief updating on average (Panel A): Among all respondents, treatment ***Norm Info*** significantly increases beliefs about the share of people who intend to get vaccinated by 4 percentage points. Beyond this treatment effect on the mean belief, we also find that the information significantly reduces the dispersion of posterior beliefs: the 10-90 percentile range is between 45% and 85% in the control group versus 60% and 80% in the treatment group ($p = 0.000$; Kolmogorov-Smirnov test). Categorizing respondents by their prior beliefs (see Section 3.1), Panel B shows that the treatment significantly increases the beliefs of those who initially underestimated the norm (i.e., underestimators) by 10 percentage points. The treatment effect for over-estimators is significant and negative at about 6.5 percentage points, and the effect for correct-estimators is small and insignificant. Consistent with the high congruence between the descriptive and the injunctive norm documented in Section 2.2.1, treatment effects on posterior beliefs about the injunctive norm are almost identical (see columns 2 and 3). In sum, the effects of treatment ***Norm Info*** on posterior beliefs show that respondents rationally update their beliefs in response to factual information about the descriptive norm.

Next, we investigate whether these strong treatment effects on beliefs translate into increased vaccination readiness. Table 4 presents regressions of our primary outcomes, the **ITV Index** and the **WTP Index**, on the ***Norm Info*** treatment indicator. Panel A of the table reveals that the treatment effect on both indices is not significant and is close to zero. Appendix Table A4 shows that the null results hold when considering the individual components of these indices. Because the information treatment affects respondents differently depending on their prior beliefs, Panel B of Table 4 distinguishes between respondents according to their prior beliefs. Again, all treatment-effect estimates are statistically insignificant and close to zero. These null effects persist when further distinguished by the confidence with which respondents hold their prior beliefs (results available upon request). Thus, while correcting misperceptions about the social norm is a necessary condition for the treatment to increase vaccination readiness, our results show that this is not sufficient.

In additional analyses, we show that the average null effect of the ***Norm Info*** treatment is not due to respondents' inattention or beliefs about herd immunity (see Appendix B). Instead, we show in the next section the average null effect is due to two counteracting effects on women and men.

3.3. Opposing Information Effects on Women and Men

Studying gender differences in how norm information affects vaccination readiness is important for at least two reasons: First, beliefs and behavior regarding COVID-19 are highly polarized by gender (e.g., Galasso et al., 2021). While women are generally more concerned about COVID-19 and more likely to adhere to public-policy measures such as wearing masks or social distancing, they also tend to show greater hesitancy to vaccinate against COVID-19 (e.g., Galasso et al., 2021; Huebener & Wagner, 2021; Steinert et al., 2021). Second, women have been shown to be more sensitive to social cues in determining appropriate behavior (e.g., Croson & Gneezy, 2009). In this section, we first show that the effect of treatment ***Norm Info*** on vaccination readiness differs fundamentally between women and men. Then

Table 3: Information effects on posterior norm beliefs

	Effect of ***Norm Info*** on ...			
	Belief Descriptive Norm (Share of German adults willing to vaccinate)		**Belief Injunctive Norm**	
	(1)	(2)	(3)	(4)
PANEL A: Information effects on all respondents				
Norm Info	4.019***	3.951***	5.355***	5.255***
	(0.560)	(0.542)	(0.624)	(0.605)
Control Mean[1]	64.805		62.663	
R-Squared	0.019	0.099	0.028	0.098
Obs.	2586	2586	2588	2588
PANEL B: Information effects by prior beliefs				
Effect on Under-estimators	10.064***	10.031***	11.610***	11.505***
	(0.737)	(0.721)	(0.811)	(0.797)
Effect on Correct-estimators	0.196	0.427	1.658	1.951
	(0.779)	(0.796)	(1.026)	(1.027)
Effect on Over-estimators	-6.421***	-6.6320***	-5.524***	-5.723***
	(0.612)	(0.637)	(0.799)	(0.818)
Covariates		✓		✓
R-Squared	0.309	0.339	0.281	0.307
Obs.	2585	2585	2587	2587

Note: OLS regressions. Independent variable: indicator for the ***Norm Info*** treatment. Dependent variables: posterior beliefs about the descriptive norm to vaccinate (columns 1-2) and about the injunctive norm to vaccinate (columns 3-4). Panel A: Average effects for all respondents. Panel B: Separate effects for subgroups classified by respondents' prior beliefs about the descriptive norm. Covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies.
[1] Mean of the outcome variable in control group
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

we explore possible mechanisms for these differences. Finally, we present information effects on policy preferences.

3.3.1. Information Effects on Vaccination Readiness of Women and Men

Table 5 presents the effects of the ***Norm Info*** treatment separately for women and men. Intriguingly, providing them with information about the descriptive norm has opposite and highly significant effects on their intentions to vaccinate.[18] While the treatment significantly increases the **ITV Index** of women

[18] To provide a comprehensive heterogeneity analysis, Appendix Table A6, splits the sample into two subgroups for each of the 19 background characteristics of respondents to estimate heterogeneous treatment effects. Gender is the only characteristic for which treatment effects are opposing and significant in both subgroups. In almost all other subgroups, the effects are not significant, with the sole exception of the positive treatment effect for individuals not living in East Germany. Note that we did not expect heterogeneity by gender ex ante, which is why we did not specify our gender analysis in advance. This should be kept in mind when interpreting our findings. Importantly, our results on gender are not only based on one single outcome variable, but are consistent across a range of primary outcome variables (i.e., different measures for vaccination readiness), mediators, and policy preferences, making it highly unlikely that the reported gender heterogeneities are a chance finding.

Table 4: Average information effects on vaccination readiness

	Effect of ***Norm Info*** on ...			
	ITV Index		**WTP Index**	
	(1)	(2)	(3)	(4)
PANEL A: Information effects on all respondents				
Norm Info	0.003	0.001	-0.187	0.047
	(0.014)	(0.011)	(2.746)	(2.598)
Control Mean[1]	0.610		37.145	
R-Squared	0.000	0.319	0.000	0.127
Obs.	2586	2586	2584	2584
PANEL B: Information effects by prior beliefs				
Effect on Under-Estimators	0.005	0.001	-0.217	-0.427
	(0.019)	(0.016)	(3.270)	(3.116)
Effect on Correct-Estimators	0.008	0.027	-1.922	0.222
	(0.033)	(0.028)	(9.424)	(9.040)
Effect on Over-Estimators	-0.006	-0.016	1.162	1.143
	(0.019)	(0.018)	(5.235)	(4.927)
Covariates		✓		✓
R-Squared	0.074	0.345	0.010	0.131
Obs.	2584	2584	2582	2582

Note: OLS regressions. Independent variable: indicator for the ***Norm Info*** treatment. Dependent variables: see description in Section 2.2.3. Panel A: Average effects for all respondents. Panel B: Separate effects for subgroups classified by respondents' prior beliefs about the descriptive norm. Covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies.

[1] Mean of the outcome variable in the control group

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

by 5.1 percentage points, it significantly decreases the index for men by 4.7 percentage points (see Panel A). Thus, the overall null effect reported in the previous section is due to offsetting effects for both genders. Since in the control group, women are much less likely to intend to get vaccinated compared to men (53.4% versus 68.7%), the treatment largely reduces the polarization of vaccination intentions across genders. Examining the treatment effects on each component of the **ITV Index** in Appendix Table A5, we find positive (negative), and mostly significant effects on each component for women (men) — including our revealed-preference measure to require a link to pre-register for COVID-19 vaccination. Results for the **WTP Index** go in the same direction but are not statistically significant.

3.3.2. Mechanism behind opposing Information Effects on Women and Men

We use rich information on potential mediators to uncover reasons why information about the descriptive norm to get vaccinated has differential effects on the vaccination readiness of women and men. Specifically, we consider the following potential mediators: changes in 1) normative opinions about COVID-19 vaccination, 2) beliefs about the reference network's vaccination behavior, 3) beliefs about

vaccine efficacy, and 4) the effects of others' vaccination decisions on respondents' vaccination decisions.

Table 6 reveals strong and heterogeneous treatment effects on these mediators.[19] While the information increases women's agreement with the normative statement that one should get vaccinated against COVID-19, it tends to decrease men's agreement (column 1). Thus, women, but not men, tend to internalize the vaccination behavior of others as their own moral rules, consistent with the notion that women are more receptive to social cues (Croson & Gneezy, 2009). The treatment also has differential effects on respondents' beliefs about their reference network (i.e., the circle of close relatives and friends who are likely to influence respondents' behavior; see Bicchieri et al. (2022b)): While the information significantly increases women's likelihood of believing that their reference network will get vaccinated, and also that their reference network expects them to get vaccinated, the effects on men tend to be negative and insignificant (columns 2 and 3). In addition, information about the descriptive norm has highly significant and opposite effects on all statements related to vaccination efficacy (columns 4 to 7). For example, the treatment increases women's trust in the vaccine while decreasing men's trust. Finally, the information has different effects on the free-riding behavior of women and men. While it decreases (increases) agreement with the statement "*If others get the vaccine, I don't get it*" among women (men) (column 8).

[19] All regressions in Table 6 include basic covariates. Results are qualitatively the same without covariates (results available upon request).

Table 5: Information effects on vaccination readiness by gender

	Effect of ***Norm Info*** on ...			
	ITV Index		**WTP Index**	
	(1)	(2)	(3)	(4)
PANEL A: Information effects on all respondents				
Effect on Women	0.051***	0.043***	2.421	1.674
	(0.019)	(0.016)	(3.611)	(3.364)
Effect on: Men	-0.047**	-0.041**	-2.817	-1.574
	(0.019)	(0.016)	(4.135)	(3.950)
Difference (p-value):	*0.000*	*0.000*	*0.340*	*0.528*
Control Mean Women[1]	0.534		34.868	
Control Mean Men[1]	0.687		39.449	
PANEL B: Information effects by prior beliefs				
Information effects on Under-Estimators				
Effect on Women	0.061**	0.058***	3.319	3.176
	(0.026)	(0.021)	(4.491)	(4.215)
Effect on Men	-0.069**	-0.066***	-3.972	-4.433
	(0.028)	(0.024)	(4.812)	(4.671)
Difference (p-value):	*0.001*	*0.000*	*0.268*	*0.228*
Information effects on Correct-Estimators				
Effect on Women	0.039	0.043	-11.425	-11.169
	(0.047)	(0.041)	(10.317)	(9.280)
Effect on Men	-0.010*	-0.014	9.000	12.690
	(0.045)	(0.039)	(15.469)	(15.139)
Difference (p-value):	*0.457*	*0.616*	*0.272*	*0.180*
Information effects on Over-Estimators				
Effect on Women	0.002	-0.019	6.319	3.603
	(0.030)	(0.029)	(7.512)	(7.039)
Effect on Men	-0.007	-0.015	-2.696	-0.862
	(0.025)	(0.023)	(7.251)	(6.842)
Difference (p-value):	*0.813*	*0.903*	*0.388*	*0.649*
Covariates		✓		✓

Note: OLS regressions. Independent variable: indicator for the ***Norm Info*** treatment separately for women and men. Dependent variables: see description in Section 2.2.3. Panel A: Average effects for all respondents. Panel B: Separate effects for subgroups classified by respondents' prior beliefs about the descriptive norm. Covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies.

[1] Mean of the outcome variable in the control group

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Information effects on potential mediators by gender

		Beliefs about reference network		Beliefs about vaccine efficacy			
	Normative opinion	My closest relatives and friends get vaccinated	My closest relatives and friends expect me to get vaccinated	Vaccination is better for me	Vaccination is better for my relatives and friends	Vaccination is better for society	I trust the COVID-19 vaccine
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Effect on Women	0.210***	0.179***	0.224***	0.217***	0.240***	0.179***	0.224***
	(0.066)	(0.063)	(0.072)	(0.071)	(0.068)	(0.065)	(0.069)
Effect on Men	-0.093	-0.078	-0.021	-0.146**	-0.146**	-0.179***	-0.223***
	(0.061)	(0.062)	(0.069)	(0.067)	(0.065)	(0.063)	(0.067)
Difference (p-value):	*0.001*	*0.004*	*0.014*	*0.000*	*0.000*	*0.000*	*0.000*

	Effects of others' behavior	
	If others get the vaccine, I don't get it	If others get the vaccine, I too get it
	(8)	(9)
Effect on Women	-0.171**	0.102
	(0.069)	(0.072)
Effect on Men	0.143**	-0.076
	(0.072)	(0.077)
Difference (p-value):	*0.002*	*0.092*

Note: OLS regressions. Independent variable: indicator for the ***Norm Info*** treatment separately for women and men. Dependent variables: see the description in Section 2.2.3 and Appendix Table A3 for details. All dependent variables are measured on a 5-point Likert scale (from 1 "I fully disagree" to 5 "I fully agree"). All regression include covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

To get an idea of what shares of the effects of treatment ***Norm Info*** on respondents' vaccination intentions can be explained by the different mediators, we conduct a mediation analysis along the lines of Pearl (2012) and (Heckman et al., 2013). Specifically, we re-estimate treatment effects on the **ITV Index** separately for women and men using the regression according to Equation 1, and then add the different mediator variables as additional controls. Inspecting coefficient movement between the regressions without and with mediators reveals how much of the treatment effect can be explained by the different mediators (see e.g., Hermes et al., 2021, for a more detailed application and discussion of the methodology).

Appendix Table A7 depicts the results. While for women each mediator entered separately explains large shares of the overall treatment effect, the most important mediator for men turns out to be altered beliefs about vaccine efficacy. When considering all mediators jointly (last column of Table A7), they explain 73% of the treatment effect for men and the entire treatment effect for women.

In sum, this section shows that women and men differ fundamentally in how they process and internalize the same information shock, i.e., correcting downward-biased beliefs about the descriptive norm to vaccinate. These differences in information processing likely explain why the information treatment has opposite effects on both genders' vaccination readiness.

3.3.3. Information Effects on Policy Preferences

Policy measures to contain the COVID-19 pandemic were at the forefront of the political and public discourse during the pandemic. Thereby, the public's preferences for different policy measures have been an important guide for what policies were implemented by politicians. In this final section, we investigate whether information about the descriptive norm also affects women's and men's policy preferences.

Table 7 presents treatment effects on policy preferences measured on a Likert scale from 1 ("*I fully disagree*") to 5 ("*I fully agree*"). In line with the effects on women's and men's vaccination readiness documented above, the treatment significantly decreases men's preferences for making COVID-19 vaccination mandatory (columns 1 and 2), and for punishing those who refuse the vaccine (columns 3 and 4). Effects for women go in the opposite direction but are statistically insignificant. Effects on preferences for granting vaccinated people more freedoms go in the same direction but are statistically not significant. Because women in the control group are less likely than men to support these policies (see control means in Table 7), the treatment decreases polarization in these policy preferences.

4. Conclusion

This study investigates how social norms affect COVID-19 vaccination readiness. Therefore, we conducted an information provision experiment in representative samples of the German adult population ($N > 5,000$) in spring 2021, at a time when large shares of the population were still unvaccinated.

Table 7: Information effects on policy preferences

	Effect of ***Norm Info*** on **policy preferences**					
	Mandatory vaccination		Punishment of vaccine refusers		Freedoms for vaccinated people	
	(1)	(2)	(3)	(4)	(5)	(6)
Effect on Women	0.042	0.035	0.080	0.066	0.127	0.100
	(0.084)	(0.077)	(0.081)	(0.076)	(0.085)	(0.081)
Effect on Men	-0.149*	-0.140*	-0.182**	-0.158**	-0.114	-0.091
	(0.087)	(0.080)	(0.084)	(0.080)	(0.087)	(0.083)
Covariates		✓		✓		✓
Difference (p-value):	*0.114*	*0.116*	*0.025*	*0.043*	*0.047*	*0.101*
Control Mean for Women[1]	2.410		2.205		2.626	
Control Mean for Men[1]	2.863		2.615		2.966	

Note: OLS regressions. Independent variable: indicator for the ***Norm Info*** treatment separately for women and men. Dependent variables: see description in Section 2.2.3 and Appendix Table A3 for details. All dependent variables are dichotomized (*one* = "I fully agree" or "I rather agree", zero else). All regression include covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies.

[1] Mean of the outcome variable in the control group

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Respondents' prior beliefs about the descriptive norm to vaccinate against COVID-19 are downward biased: They on average think that only 62% intend to get vaccinated, whereas the actual share is 70%. Randomly providing factual information about the existing social norm is successful in correcting respondents' average beliefs, and also reduces belief dispersion (which is substantial in the control group). The information treatment has a precisely estimated null overall effect on vaccination readiness, which is due to opposite and significant effects for women (positive) and men (negative). Since in the control group women exhibit much lower vaccination readiness than men, the norm information reduces polarization in vaccination readiness across genders. Studying the mechanism why information about the social norm affects women and men differently, we show that both genders differ fundamentally in how they process the provided information. Thus, it is important to account for possible channels through which descriptive norm information can influence behavior when designing norm-nudge interventions to avoid that interventions backfire.

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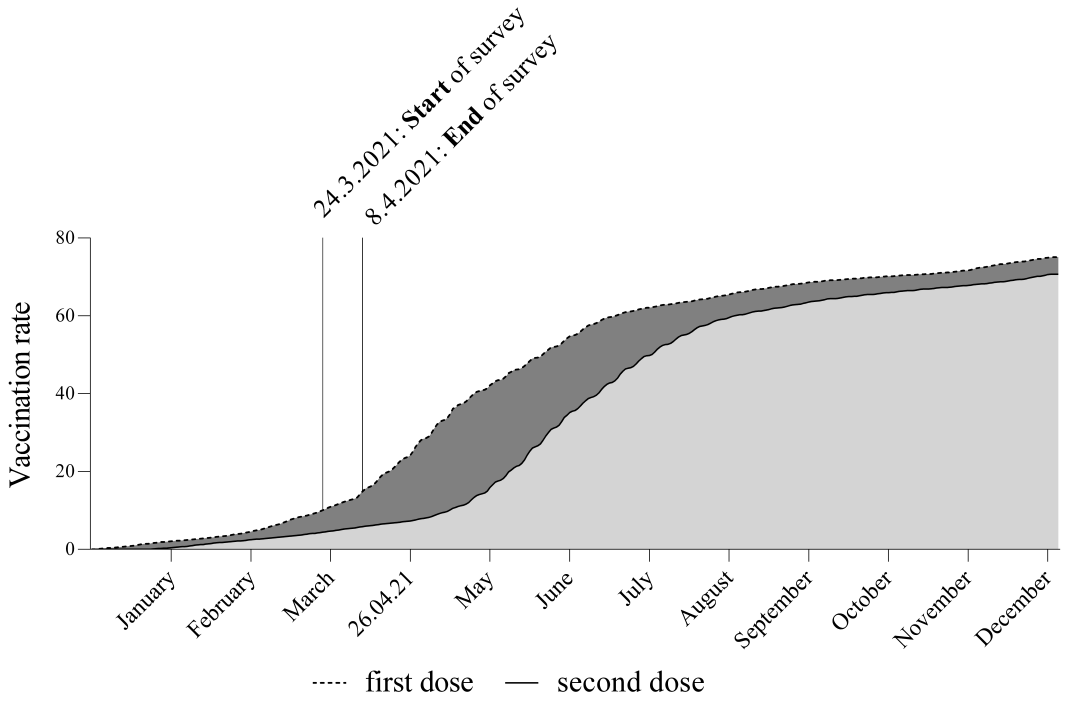
Appendix A Additional Figures and Tables

Figure A1: Vaccination rates of the German adult population



Note: Source: Bundesministerium für Gesundheit (2022)

Table A1: Exact wording and translation of selected survey items: Outcomes.

	English Translation	German Original
Wave 1		
	To what extent do you agree with the following statement? "*I will get vaccinated against COVID-19 as soon as a vaccine is available for me.*"	Inwieweit stimmen Sie folgender Aussage zu? "*Ich lasse mich gegen COVID-19 impfen, sobald eine Schutzimpfung für mich verfügbar ist.*"
Wave 2		
Information for **all** respondents:	From March 24 to April 2, 2021, a similar survey was conducted with people **aged 18 to 69**. All respondents were selected to represent the overall population in Germany as well as possible.	Vom 24.3. bis zum 2.4.2021 wurde eine ähnliche Befragung mit Personen im Alter von **18 bis 69 Jahren** durchgeführt. Diese Befragten wurden so ausgewählt, dass sie die Gesamtbevölkerung in Deutschland möglichst gut abbilden.
	Guessing Question: What do you guess is the percentage of respondents who agree with the following statement? "*I will get vaccinated against COVID-19 as soon as a vaccine is available for me.*"	**Schätzfrage**: Was schätzen Sie, wie hoch ist der Anteil der Befragten, der folgender Aussage zustimmt? "*Ich lasse mich gegen COVID-19 impfen, sobald eine Schutzimpfung für mich verfügbar ist.*"
Information for respondents in ***Norm Info***:	In the survey from March 24 to April 2, 2021, **70 of 100 respondents** agreed or strongly agreed with the statement "I will get vaccinated against COVID-19 as soon as a vaccine is available for me.".	In der Befragung vom 24.3. bis zum 2.4.2021, stimmten **70 von 100 Befragten** der Aussage „Ich lasse mich gegen COVID-19 impfen, sobald eine Schutzimpfung für mich verfügbar ist." voll oder eher zu.
	To what extent do you agree with the following statement?	Inwieweit stimmen Sie folgender Aussage zu?
ITV overall	"*I will get vaccinated against COVID-19 as soon as a vaccine is available for me.*"	"*Ich lasse mich gegen COVID-19 impfen, sobald eine Schutzimpfung für mich verfügbar ist.*"
WTP (me)	Now it's a question of how much a vaccination against COVID-19 would be worth to you: What is the most you would be willing to pay to be vaccinated tomorrow with the vaccine of your choice?	Jetzt geht es darum, wie viel Ihnen ein Impfschutz gegen COVID-19 wert wäre: Wie viel wären Sie höchstens bereit dafür zu bezahlen, dass Sie morgen mit dem Impfstoff Ihrer Wahl geimpft werden?
WTP (other)	And what is the most you would be willing to pay to have a person of your choice (not you) vaccinated against COVID-19 tomorrow with the vaccine of your choice?	Und wie viel wären Sie höchstens bereit dafür zu bezahlen, dass eine Person Ihrer Wahl (nicht Sie) morgen mit dem Impfstoff Ihrer Wahl geimpft wird?
Link to pre-registration	Would you like to receive a link to pre-register for a COVID-19 vaccination at the end of this survey?	Möchten Sie am Ende dieser Befragung einen Link zur Voranmeldung für eine COVID-19-Schutzimpfung erhalten?
	To what extent do you agree with the following statement?	Inwieweit stimmen Sie folgender Aussage zu?
	"If I had the chance, tomorrow I would get …"	„Hätte ich die Möglichkeit, würde ich mich morgen …"
ITV Astra Zeneca	"… vaccinated with **AstraZeneca's** vaccine"	„… mit dem Impfstoff von **AstraZeneca** impfen lassen."
ITV BioNTech	"… vaccinated with **BioNTech and Pfizer's** vaccine"	„… mit dem Impfstoff von **BioNTech und Pfizer** impfen lassen."
	Guessing Question: What do you guess is the percentage of the German adult population who agree with the following statement?	**Schätzfrage**: Was schätzen Sie, wie hoch ist der Anteil der erwachsenen Bevölkerung in Deutschland, der folgender Aussage zustimmt?
Belief: Descriptive Norm	"*I will get vaccinated against COVID-19 as soon as a vaccine is available for me.*"	"*Ich lasse mich gegen COVID-19 impfen, sobald eine Schutzimpfung für mich verfügbar ist.*"
	Guessing Question: What do you guess is the percentage of the German adult population who agree with the following statement?	**Schätzfrage**: Was schätzen Sie, wie hoch ist der Anteil der erwachsenen Bevölkerung in Deutschland, der folgender Aussage zustimmt?
Belief: Injunctive Norm	"*People should get vaccinated against COVID-19 as soon as a vaccine is available.*"	"*Man sollte sich gegen COVID-19 impfen lassen sobald eine Schutzimpfung verfügbar ist.*"

Note: Exact wording of selected survey items (left) and original German version (right). Please refer to Appendix C to see the complete (translated) survey.

Table A2: Correlations between various measures of vaccination readiness and real outcome

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) ITV overall	1.000							
(2) ITV vaccine of choice	0.789***	1.000						
(3) ITV Astra Zeneca	0.543***	0.447***	1.000					
(4) ITV BioNTech	0.556***	0.451***	0.040**	1.000				
(5) Link to pre-registration	0.432***	0.363***	0.301***	0.287***	1.000			
(6) WTP me	0.326***	0.277***	0.228***	0.231***	0.727***	1.000		
(7) WTP other	0.282***	0.221***	0.213***	0.219***	0.224***	0.173***	1.000	
(8) Click on Link	0.257***	0.191***	0.211***	0.189***	0.199***	0.150***	0.842***	1.000

Note: Person correlation-coefficients between various measures of vaccination readiness, and a real outcome, namely whether respondents clicked on the link to pre-register for a COVID-19 vaccine. See the description in Section 2.2.3 for a description of the variables.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3: Exact wording and translation of selected survey items: Mediators and Policy Preferences.

	English Translation	German Original
Panel A: Mediators		
Normative opinions	[1] People should get vaccinated against COVID-19 as soon as a vaccine is available.	Man sollte sich gegen COVID-19 impfen lassen, sobald eine Schutzimpfung verfügbar ist.
Beliefs about reference network	[2] I think most of my closest circle of relatives and friends are getting vaccinated against COVID-19.	Ich glaube mein engster Verwandten- und Bekanntenkreis lässt sich mehrheitlich gegen COVID-19 impfen.
	[3] I think my closest circle of relatives and friends expect me to get vaccinated against COVID-19.	Ich glaube mein engster Verwandten- und Bekanntenkreis erwartet von mir, dass ich mich gegen COVID-19 impfen lasse.
	[4] The expectations of my relatives and friends are important for my own vaccination decision.	Die Erwartung meiner Verwandten und Bekannten ist für meine eigene Impfentscheidung wichtig.
Beliefs about vaccine efficacy	[5] It is better for me to get vaccinated against COVID-19.	Es ist für mich besser, wenn ich mich gegen COVID-19 impfen lasse.
	[6] It is better for my relatives and friends if I get vaccinated against COVID-19.	Es ist für meine Verwandten und Bekannten besser, wenn ich mich gegen COVID-19 impfen lasse.
	[7] It is better for society if I get vaccinated against COVID-19.	Es ist für die Gesellschaft besser, wenn ich mich gegen COVID-19 impfen lasse.
	[8] I completely trust the COVID-19 vaccine.	Ich habe volles Vertrauen in die COVID-19-Schutzimpfung.
Effects of others' behavior on own vaccination decision	[9] If many others get vaccinated, then I will get vaccinated as well.	Wenn sich viele andere impfen lassen, dann lasse ich mich auch impfen.
	[10] If many others get vaccinated, I do not need to be vaccinated as well.	Wenn viele andere gegen COVID-19 geimpft sind, muss ich mich nicht auch noch impfen lassen.
Panel B: Policy Preferences		
Mandatory vaccination	[11] The COVID-19 vaccination should be mandatory for all.	Die COVID-19-Schutzimpfung sollte für alle verpflichtend sein.
Punishment of vaccine refusers	[12] I am in favor of punishing individuals who refuse a COVID-19 vaccination (e.g., by restricting their freedom to travel or banning them from certain professions).	Ich bin dafür, dass Personen, die eine COVID-19-Schutzimpfung verweigern, bestraft werden (z.B. durch Einschränkung ihrer Reisefreiheit oder Berufsausübungsverbot für bestimmte Berufsgruppen).
Freedoms for vaccinated people	[13] I am in favor of giving vaccinated people legal advantages (e.g., being allowed to go to restaurants or fly without testing).	Ich bin dafür, dass geimpfte Personen rechtliche Vorteile erhalten (z.B. ohne Test ins Restaurant gehen oder fliegen dürfen).

Note: Exact wording of selected survey items (left) and original German version (right). Please refer to Appendix C to see the complete (translated) survey. Agreements were measured on a 5-point scale (1: "I fully disagree", 2: "I rather disagree", 3: "neither nor", 4: "I rather agree", and 5: "I fully agree"). In this paper, we refer to these statements as: [1] Normative opinion. [2] My closest relatives and friends get vaccinated. [3] My closest relatives and friends expect me to get vaccinated. [4] The expectation of close relatives and friends is important. [5] Vaccination is better for me. [6] Vaccination is better for my relatives and friends. [7] Vaccination is better for society. [8] I trust the COVID-19 vaccine. [9] If others get the vaccine, I too get it. [10] If others get the vaccine, I don't get it. [11] Mandatory vaccination. [12] Punishment of vaccine refusers. [13] Freedoms for vaccinated people.

Table A4: Information effects on various measures of vaccination readiness

	ITV Index		ITV Overall		ITV Vaccine of Choice		ITV Astra Zeneca		ITV BioNTech		Link to pre-registration	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Norm Info	0.003	0.001	0.003	0.001	0.012	0.010	-0.002	-0.004	0.017	0.012	-0.012	-0.013
	(0.014)	(0.011)	(0.018)	(0.015)	(0.017)	(0.015)	(0.020)	(0.018)	(0.020)	(0.018)	(0.020)	(0.018)
Covariates		✓		✓		✓		✓		✓		✓
Control Mean[1]	0.610		0.714		0.760		0.524		0.510		0.540	
R-Squared	0.000	0.319	0.000	0.261	0.000	0.175	0.000	0.146	0.000	0.143	0.000	0.185
Obs.	2586	2586	2590	2590	2590	2590	2587	2587	2588	2588	2590	2590

	WTP Index		WTP Me		WTP Other	
	(13)	(14)	(15)	(16)	(17)	(18)
Norm Info	-0.187	0.047	0.569	0.781	-0.944	-0.686
	(2.746)	(2.598)	(2.650)	(2.526)	(3.072)	(2.914)
Covariates		✓		✓		✓
Control Mean[1]	37.145		34.263		40.026	
R-Squared	0.000	0.127	0.000	0.112	0.000	0.123
Obs.	2584	2584	2584	2584	2584	2584

Note: OLS regressions. Independent variable: indicator for the ***Norm Info*** treatment. The dependent variables are various measures of vaccination readiness: see description in Section 2.2.3. Covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies.

[1] Mean of the outcome variable in the control group

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A5: Information effects on various measures of vaccination readiness by gender

PANEL A	ITV Overall		ITV Vaccine of Choice		ITV Astra Zeneca		ITV BioNTech		ITV to pre-registration		WTP Me		WTP Other	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Effect on Women	0.053**	0.043*	0.075***	0.068***	0.018	0.010	0.063**	0.050*	0.047*	0.042*	2.434	1.862	2.409	1.486
	(0.026)	(0.023)	(0.024)	(0.022)	(0.028)	(0.026)	(0.028)	(0.026)	(0.028)	(0.025)	(3.383)	(3.173)	(4.207)	(3.946)
Effect on Men	-0.049**	-0.041*	-0.052**	-0.048**	-0.024	-0.019	-0.032	-0.026	-0.072***	-0.068***	-1.341	-0.297	-4.292	-2.861
	(0.024)	(0.021)	(0.022)	(0.021)	(0.027)	(0.026)	(0.027)	(0.026)	(0.027)	(0.025)	(4.075)	(3.922)	(4.479)	(4.272)
Difference (p-value):	*0.004*	*0.007*	*0.000*	*0.000*	*0.284*	*0.433*	*0.015*	*0.038*	*0.002*	*0.002*	*0.476*	*0.668*	*0.276*	*0.455*
Control Mean for Women[1]	0.642		0.701		0.445		0.428		0.454		31.726		38.011	
Control Mean for Men[1]	0.787		0.820		0.606		0.593		0.627		36.832		42.066	
PANEL B: Information effects on Under-Estimators														
Effect on Women	0.058*	0.055*	0.092***	0.092***	0.005	0.003	0.087**	0.078**	0.064*	0.066**	2.044	2.169	4.594	4.322
	(0.035)	(0.030)	(0.033)	(0.029)	(0.035)	(0.032)	(0.035)	(0.032)	(0.035)	(0.031)	(4.120)	(3.907)	(5.383)	(5.076)
Effect on Men	-0.059	-0.053*	-0.087**	-0.085***	-0.047	-0.047	-0.062	-0.059*	-0.079**	-0.076**	-0.989	-1.582	-6.956	-7.285
	(0.036)	(0.032)	(0.034)	(0.031)	(0.038)	(0.036)	(0.038)	(0.035)	(0.038)	(0.035)	(4.729)	(4.621)	(5.127)	(4.964)
Difference (p-value):	*0.020*	*0.014*	*0.000*	*0.000*	*0.313*	*0.296*	*0.004*	*0.005*	*0.005*	*0.003*	*0.629*	*0.552*	*0.120*	*0.102*
PANEL C: Information effects on Correct-Estimators														
Effect on Women	0.021	0.029	0.081	0.083	0.042	0.042	-0.006	-0.002	0.055	0.061	-4.568	-4.394	-18.282	-17.944
	(0.066)	(0.060)	(0.061)	(0.057)	(0.077)	(0.077)	(0.078)	(0.074)	(0.076)	(0.069)	(10.303)	(9.443)	(11.220)	(10.090)
Effect on Men	0.020	0.055	0.010	0.032	0.053	0.077	-0.039	-0.013	-0.092	-0.080	13.639	17.231	4.361	8.149
	(0.052)	(0.049)	(0.051)	(0.049)	(0.071)	(0.067)	(0.070)	(0.067)	(0.070)	(0.065)	(15.967)	(15.703)	(16.166)	(15.802)
Difference (p-value):	*0.987*	*0.744*	*0.372*	*0.490*	*0.919*	*0.734*	*0.754*	*0.910*	*0.156*	*0.137*	*0.338*	*0.238*	*0.250*	*0.165*
PANEL D: Information effects on Over-Estimators														
Effect on Women	0.013	-0.013	-0.002	-0.020	0.019	-0.002	0.012	-0.013	-0.033	-0.049	5.943	3.728	6.696	3.478
	(0.040)	(0.039)	(0.037)	(0.039)	(0.056)	(0.055)	(0.055)	(0.055)	(0.055)	(0.053)	(7.072)	(6.643)	(8.505)	(8.013)
Effect on Men	-0.036	-0.047	-0.003	-0.011	-0.003	-0.004	0.037	0.030	-0.032	-0.040	-4.962	-3.412	-0.430	1.689
	(0.029)	(0.027)	(0.030)	(0.030)	(0.044)	(0.043)	(0.046)	(0.045)	(0.044)	(0.042)	(6.933)	(6.589)	(8.207)	(7.744)
Difference (p-value):	*0.325*	*0.473*	*0.975*	*0.860*	*0.752*	*0.974*	*0.731*	*0.545*	*0.987*	*0.893*	*0.271*	*0.448*	*0.547*	*0.872*
Covariates		✓		✓		✓		✓		✓		✓		✓

Note: OLS regressions. Independent variable: indicator for the ***Norm Info*** treatment separately for women and men. The dependent variables are various measures of vaccination readiness: see description in Section 2.2.3. Panel A: Average effects separately for women and men. Panels B-D: Separate effects for subgroups classified by respondents' prior beliefs about the descriptive norm. Covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies.

[1] Mean of the outcome variable in the control group

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A6: Heterogeneous effect of providing information on an index for intentions to vaccinate (**ITV Index**) for respondents in different subgroups

	Respondents' characteristics (subgroup)	Treatment effect (subgroup)		Not (¬) subgroup	Treatment effect (¬ subgroup)		*Differences* (p-values)
(a)	Female	0.043***	(0.016)	Male	-0.041**	(0.016)	*0.000*
(b)	Age 18 – 46	-0.010	(0.016)	Age 47 – 69	0.010	(0.016)	*0.379*
(c)	Born in Germany	-0.039	(0.047)	**Not** born in Germany	0.003	(0.012)	*0.374*
(d)	Living in the east of Germany	-0.013	(0.013)	**Not** living in the east of Germany	0.057**	(0.017)	*0.016*
(e)	Equivalized household size ($\leq$ 1.5)	0.006	(0.014)	Equivalized household size ($>$ 1.5)	-0.009	(0.020)	*0.541*
(f)	Equivalized household income ($\leq$ 1,580€)	0.005	(0.016)	Equivalized household income ($>$ 1,580€)	-0.003	(0.016)	*0.714*
(g)	University degree	0.004	(0.012)	**No** University degree	-0.029	(0.031)	*0.358*
(h)	University entrance qualification	0.013	(0.015)	**No** University entrance qualification	-0.018	(0.018)	*0.175*
	Work						
(i)	Currently working	-0.008	(0.018)	Currently **not** working	0.007	(0.015)	*0.525*
(j)	Working in health sector	-0.003	(0.012)	**Not** working in health sector	0.077	(0.057)	*0.174*
(k)	Working in system-relevant job	-0.005	(0.012)	**Not** working in system-relevant job	0.040	(0.032)	*0.194*
	Political Party Preferences						
(l)	Conservative	0.014	(0.014)	**Not** Conservative	-0.023	(0.018)	*0.114*
(m)	AfD supporter	0.003	(0.012)	**No** AfD supporter	-0.001	(0.041)	*0.930*
	Economic Preferences						
(n)	Low altruism§	0.019	(0.020)	High altruism	-0.009	(0.014)	*0.248*
(o)	Low risk-taking§	0.003	(0.017)	High risk-taking	-0.002	(0.015)	*0.810*
(p)	Low patience§	-0.004	(0.017)	High patience	0.005	(0.016)	*0.703*
(q)	Low trust in other people§	0.013	(0.016)	High trust in other people	-0.010	(0.016)	*0.402*
(r)	Low trust in government§	-0.001	(0.017)	High trust in government	0.004	(0.014)	*0.833*
(s)	Low trust in Science §	0.006	(0.013)	High trust in Science	-0.009	(0.023)	*0.562*

Note: OLS regressions. Independent variable: indicator for the ***Norm Info*** treatment separately for subgroups defined over respondents' characteristics. Dependent variable: see description in Section 2.2.3. All regression include covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies. .

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A7: Information effect on intentions to vaccinate by gender. Accounting for likely mediators.

	Effect of ***Norm Info*** on **ITV Index**					
	(1)	(2)	(3)	(4)	(5)	(6)
Effect on Women	0.043***	0.005	0.014	-0.001	0.019	-0.005
	(0.016)	(0.011)	(0.014)	(0.011)	(0.013)	(0.010)
Effect on Men	-0.041**	-0.023**	-0.037**	-0.006	-0.024*	-0.011
	(0.016)	(0.011)	(0.014)	(0.011)	(0.013)	(0.010)
	Mediators					
Normative Opinions		✓				✓
Beliefs about reference network			✓			✓
Beliefs about vaccine efficacy				✓		✓
Effects of others' behavior					✓	✓
R-squared	0.323	0.680	0.484	0.699	0.547	0.746
Obs.	2586	2586	2585	2583	2584	2583

Note: OLS regressions. Independent variable: indicator for the ***Norm Info*** treatment separately for women and men. Dependent variable: see description in Section 2.2.3. We consider various mediating channels through which our information provision could have affected respondents' intentions to vaccinate. Hence, we asked respondents for their agreement with various statements, measured on a 5-point Likert scale (1 "I fully disagree", 2 "I rather disagree", 3 "neither nor", 4 "I rather agree", and 5 "I fully agree"). Refer to Table A3 for a detailed description of these statements. We summarized statements representing similar topics into indices by simply calculating the average of respondents' answers. **Mediators**: *Normative Opinions*, which is a single statement capturing respondents' opinions concerning the norm to get vaccinated against COVID-19. *Beliefs about reference network* consists of three statements capturing social pressure concerns, namely whether their closest friends and relatives get vaccinated, whether respondents think that they expect them to get vaccinated as well, and whether these expectations are important to them. *Beliefs about vaccine efficacy* consists of four statements, capturing whether respondents think that vaccination is better for them, their friends and relatives, or society and whether they trust the COVID-19 vaccine. *Effects of others' behavior* on own vaccination decision captures whether respondents would free-ride on the vaccination decision of others. All regressions include covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A8: Average information effects on vaccination readiness

	Effect of ***Norm Info*** on ...			
	ITV Index		**WTP Index**	
	(1)	(2)	(3)	(4)
PANEL A: Information effects on all respondents				
Norm Info	0.003	0.001	-0.187	0.047
	(0.014)	(0.011)	(2.746)	(2.598)
Control Mean[1]	0.610		37.145	
R-Squared	0.000	0.319	0.000	0.127
Obs.	2586	2586	2584	2584
PANEL B: Information effects by attentiveness				
Effect on inattentive respondents	-0.022	-0.011	-2.000	-1.967
	(0.028)	(0.023)	(5.005)	(4.816)
Effect on attentive respondents	0.013	0.005	0.598	0.809
	(0.016)	(0.013)	(3.279)	(3.095)
Difference (p-value):	*0.270*	*0.543*	*0.664*	*0.629*
PANEL C: Information effects by belief about herd immunity (HI)				
Effect on respondents believing that HI will be reached	0.000	-0.001	-5.975	-6.285
	(0.021)	(0.016)	(4.090)	(3.848)
Effect on respondents believing that HI will **not** be reached	0.001	-0.002	5.416	6.206
	(0.017)	(0.016)	(3.649)	(3.489)
Difference (p-value):	*0.966*	*0.966*	*0.038*	*0.017*
Covariates		✓		✓

Note: OLS regressions. Independent variable: indicator for the ***Norm Info*** treatment. Dependent variables: see description in Section 2.2.3. Panel A: Average effects for all respondents. Panel B (C): Separate effects for subgroups classified by respondents' attentiveness (beliefs concerning the vaccination coverage rate needed to achieve herd immunity). Covariates: Female, age, born in Germany, living in East Germany, equivalized household income, university degree, highest school degree, currently working, work in the health sector, work in a system-relevant job, political party preferences, already had COVID-19, risk group, contact risk group, economic preferences (see Table 1 for a description of these variables). Missing values of covariates are imputed. All regressions include imputation dummies.

[1] Mean of the outcome variable in the control group

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix B Additional Information and Results

Vaccination rollout in Germany. The vaccination rollout in Germany started with the EU authorization of the mRNA vaccine Comirnaty from BioNTech on December 21, 2020, and the consecutive batch release for Germany by the Paul-Ehrlich-Institut, Federal Institute for Vaccines and Biomedicines, on December 22, 2020. The initial vaccination roll-out was relatively slow, increasing from 10% to 22% of the population during our field phase (from 24 March to 21 April 2021). By the end of 2021, almost 74% of the population received at least one dose of a COVID-19 vaccine. Appendix Figure A1 shows the development of vaccination rates in Germany from the start of the rollout until the end of January 2021. Due to supply shortages and logistical challenges, the rollout progressed only slowly until the end of March. At the start of our second survey on April 8, 2021, only a small proportion of 14.8% of the German population had been vaccinated at least once. These were mainly elderly people and healthcare professionals who were prioritized based on the vaccine prioritization plan Bundesministerium für Gesundheit (2022); Bundesregierung (2021).

Polling details. Respondi sent a link to the survey to 11,252 (17,753) people in the first (second) wave, from which 9,653 or 86% (15,577 or 88%) opened the link. From those, 2,296 or 24% (3,685 or 24%) started the survey, and 2,182 or 23% (3,315 or 21%) finished it in the first (second) wave. Respondi adjusted both samples to match official population statistics by deleting 152 (270) observations, which leaves a final sample of 2.030 (3,045) respondents in the first (second) survey. Respondents complete the survey online on their own digital devices, without any assistance from a surveyor. The median response time was 6:40 minutes (14:00 minutes) for the first (second) survey. The first wave also included a vignette experiment to test the effect of the type and duration of approval procedures on vaccination readiness Angerer et al. (2022b). Importantly, the vignette experiment was conducted only after eliciting the descriptive and injunctive norms about COVID-19 vaccination. When eliciting the norms, we placed the category "neither nor" below the other four answer categories to minimize the error of central tendency. Lergetporer & Woessmann (2019) confirm that this reduces the error of central tendency without affecting the relative frequency of the other answer categories.

Other possible reasons for the average null effect. We explore two possible reasons for why treatment ***Norm Info*** does not affect vaccination readiness on average. First, a general concern with information experiments is that respondents may not react to the provided information because they do not pay enough attention (Settele, 2022). To study this possibility, we asked the following attention-check question: "*It sometimes happens that survey participants do not read individual questions accurately. To ensure that you read the questions accurately, we ask you to ignore the following question and enter the number twenty-two in the text box. The federal states are responsible for organizing vaccination against COVID-19. In how many states do you estimate that primary care physicians are already providing vaccination nationwide*? In _____ of the total of 16 federal states" Classifying respondents who answered the question with "22" as attentive (74%), and the rest as inattentive (26%), we do not find different information effects for both groups (see Panel B of Appendix Table A8). Thus, consistent with the strong treatment effects on posterior beliefs, inattention does not explain the average null effect on vaccination readiness.

Second, the null effect could be due to respondents' beliefs about the vaccination coverage rate needed to

achieve herd immunity. Specifically, respondents might believe that a vaccination coverage rate of less than 70% the share of people intending to get vaccinated (descriptive norm) – is sufficient for reaching herd immunity. In this case, they might even reduce their own vaccination readiness if informed about the descriptive norm, since herd immunity would be achieved anyhow. However, treatment effects on the intentions to vaccinate do not differ according to respondents' beliefs about the vaccination coverage required to achieve herd immunity (see Panel C of Appendix Table A8), so this possible explanation for our null effect does not hold.

Appendix C Online Surveys

C.1 First Survey-Wave

To start with, a couple of questions concerning you.

[S1_s01] I am ...

- o Female
- o Male
- o Diverse

[S1_s02] When were you born?

Month: _____ Year: _____

[S1_s03] What is your highest general education degree?

- o No general school leaving certificate
- o Elementary school certificate
- o Secondary school certificate
- o Advanced technical college certificate
- o High school diploma
- o I am currently a student

[S1_s04] What professional training degree do you have?

Please tick all that apply.

- o I do not have a professional training and am not in professional training.
- o I have completed professional-in-company training (apprenticeship) or professional -school training (professional school, commercial school).
- o I have completed training at a technical school, master craftsman school, technical school, professional- or technical academy.
- o I have a polytechnic degree (e.g., diploma, bachelor, master).
- o I have a university degree (e.g., diploma, state examination, bachelor, master).
- o I have another professional degree.
- o I am still in professional training (trainee, apprentice, professional-/ commercial school).
- o I am a student.

[S1_s05] In which state do you live?

[Dropdown with federal states]

[Introduction]

With this survey, we would like to learn more about the attitude of the population in Germany toward COVID-19 vaccination. In addition to questions on the topic of vaccination, we would like to ask you further questions about yourself towards the end of the questionnaire. If you do not wish to answer a question, please simply skip the corresponding questions. Answering the questionnaire will take about 10 minutes. Of course, the survey is anonymous and your answers will be treated with absolute confidentiality. The anonymized data set with the answers of all respondents will be made available to the scientific community after the survey for research purposes only. By clicking "Continue" below, you agree to this provision. No conclusions about your person can be drawn from the data.

We are simply interested in your spontaneous assessments and opinions. Your payoff is independent of your answers. Therefore, please always provide an answer if possible, even if you are a little unsure. The "Next" button will take you to the next question.

Thank you for your participation!

[S1_q01] To what extent do you agree with the following statement?
"I will get vaccinated against COVID-19 as soon as a vaccine is available for me."
(If you have already been vaccinated, please put yourself in the situation as if you have not yet been vaccinated).

- o I fully agree
- o I rather agree
- o I rather disagree
- o I fully disagree
- o Neither nor

[S1_q02] To what extent do you agree with the following statement?
"People should get vaccinated against COVID-19 as soon as a vaccine is available."

- o I fully agree
- o I rather agree
- o I rather disagree
- o I fully disagree
- o Neither nor

[Information: This survey is conducted with people **aged 18 to 69**. All respondents were selected to represent the overall population in Germany as well as possible. Here are some guessing questions where you should estimate the answers of the "respondents" as well as possible.]

[S1_q03] Guessing Question: What do you guess is the percentage of respondents who agree with the following statement?

"I will get vaccinated against COVID-19 as soon as a vaccine is available for me."
(If you have already been vaccinated, please put yourself in the situation as if you have not yet been vaccinated).

- o I fully agree
- o I rather agree
- o I rather disagree
- o I fully disagree
- o Neither

_____ of 100 respondents agree "fully" or "rather" with the statement.

[S1_q03s] How confident are you that your answer is approximately correct?

Very unconfident						Very confident
O	O	O	O	O	O	O

[S1_q04] Guessing Question: What do you guess is the percentage of respondents who agree with the following statement?

"People should get vaccinated against COVID-19 as soon as a vaccine is available."

- o I fully agree
- o I rather agree
- o I rather disagree
- o I fully disagree
- o Neither

_____ of 100 respondents agree "fully" or "rather" with the statement.

[S1_q04s] How confident are you that your answer is approximately correct?

Very unconfident						Very confident
O	O	O	O	O	O	O

[Vignette-Experiment[i]]

[i] At this stage, we ran an unrelated vignette experiment. For detailed instructions please refer to Angerer et al. (2022b).

C.2 Second Survey-Wave

[Same questions (gender, age, schooling, professional training, and residence) as in the first survey.]
See previous section (Section C.1).

[Introduction]

With this survey, we would like to learn more about the attitude of the population in Germany towards COVID-19 vaccination. In addition to questions on the topic of vaccination, we would like to ask you further questions about yourself towards the end of the questionnaire. If you do not wish to answer a question, please simply skip the corresponding questions. Answering the questionnaire will take about 15 minutes. Of course, the survey is anonymous, and your answers will be treated with absolute confidentiality. The anonymized data set with the answers of all respondents will be made available to the scientific community after the survey for research purposes only. By clicking "Continue" below, you agree to this provision. No conclusions about your person can be drawn from the data. We are simply interested in your spontaneous assessments and opinions. Therefore, please always provide an answer if possible, even if you are a little unsure. The "Next" button will then take you to the next question. There are questions in the survey where you can earn an additional reward. The text of each question indicates the possibility and the amount of an additional payment. Any additional payment will be credited to you after the data has been analyzed within the next four weeks.

Thank you very much for your participation!

[S2_q01] What do you estimate is the proportion of the population that needs to be vaccinated against the COVID-19 virus for non-vaccinated individuals to be protected ("herd immunity")?

_____ of 100 people need to be vaccinated.

[S2_q01s] How confident are you that your answer is approximately correct?

Very unconfident						Very confident
O	O	O	O	O	O	O

[Information to Respondents]

From March 24 to April 2, 2021, a similar survey was conducted with people **aged 18 to 69**. All respondents were selected to represent the overall population in Germany as well as possible.

[S2_q02] Guessing Question: What do you guess is the percentage of respondents who agree with the following statement?

"I will get vaccinated against COVID-19 as soon as a vaccine is available for me."
(If you have already been vaccinated, please put yourself in the situation as if you have not yet been vaccinated).

- o I fully agree
- o I rather agree
- o I rather disagree
- o I fully disagree
- o Neither

_____ of 100 respondents agree "fully" or "rather" with the statement.

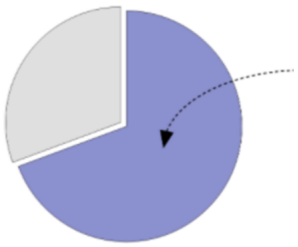
[S2_q02s] How confident are you that your answer is approximately correct?

Very unconfident						Very confident
O	O	O	O	O	O	O

[Start of experimental variation:]

[Control Group]: no information

[***Norm Info***]: In the survey from March 24 to April 2, 2021, **70 of 100 respondents** "fully agreed" or "rather agreed" with the statement *"I will get vaccinated against COVID-19 as soon as a vaccine is available for me."*



70 of 100 respondents say they will **vaccinate**

These numbers are based on a survey of 2,030 people between the ages of 18 and 69 living in Germany. The survey was conducted from March 24 to April 2, 2021.

[Until the end of the experimental variation, we presented respondents in ***Norm Info*** the following reminder at the top of every screen:]

Reminder: **70 out of 100 respondents** fully or rather agree with the statement "*I will get vaccinated against COVID-19 as soon as a vaccine is available for me.*".

[S2_q03] To what extent do you agree with the following statement?
"I will get vaccinated against COVID-19 as soon as a vaccine is available for me."
(If you have already been vaccinated, please put yourself in the situation as if you have not yet been vaccinated).

- o I fully agree
- o I rather agree
- o I rather disagree
- o I fully disagree
- o Neither nor

[S2_q04] To what extent do you agree with the following statement?
"People should get vaccinated against COVID-19 as soon as a vaccine is available."

- o I fully agree
- o I rather agree
- o I rather disagree
- o I fully disagree
- o Neither nor

[S2_q05] Guessing Question: What do you guess is the percentage of respondents who agree with the following statement?

"People should get vaccinated against COVID-19 as soon as a vaccine is available."

- o I fully agree
- o I rather agree
- o I rather disagree
- o I fully disagree
- o Neither

_____ of 100 respondents agree "fully" or "rather" with the statement.

[S2_q05s] How confident are you that your answer is approximately correct?

Very unconfident						Very confident
O	O	O	O	O	O	O

[S2_q06] To what extent do you agree with the following statement?
"**If I could choose the vaccine myself**, I would get vaccinated against COVID-19 as soon as a vaccine is available for me."
(If you have already been vaccinated, please put yourself in the situation as if you have not yet been vaccinated).

- o I fully agree
- o I rather agree
- o I rather disagree
- o I fully disagree
- o Neither nor

[S2_q07] Now it's a question of how much a vaccination against COVID-19 would be worth to you: What is the most you would be willing to pay to be vaccinated tomorrow with the vaccine of your choice?
(State the most you would pay out of your own pocket if the vaccine were available for you to purchase. Please indicate "0" Euros if you do not want to be vaccinated with this vaccine. If you have already been vaccinated, please put yourself in the situation as if you have not yet been vaccinated.)

_____ Euro

[S2_q08] And what is the most you would be willing to pay to have a person of your choice (not you) vaccinated against COVID-19 tomorrow with the vaccine of your choice?
State the maximum amount you would pay out of your own pocket if the vaccine were available for you to purchase. Please indicate "0" euro if you do not want a person of your choice to be vaccinated with this vaccine.)

_____ Euro

[S2_q09] Would you like to receive a link to pre-register for a COVID-19 vaccination at the end of this survey?

- o Yes
- o No

[If "Yes" a pop-up appeared with the text: "*Thank you for your interest. At the end of the questionnaire, we will provide you with a link to find relevant pre-registration information in your state.*"]

[S2_q09f] Have you already pre-registered for the COVID-19 vaccination?

- o Yes
- o No

[S2_q10-11] To what extent do you agree with the following statement?
"If I had the chance, tomorrow I would get..."
(If you have already been vaccinated, please put yourself in the situation as if you have not yet been vaccinated).

	I fully agree	I rather agree	I rather disagree	I fully disagree	Neither
... vaccinated with AstraZeneca's vaccine.	O	O	O	O	O
... vaccinated with BioNTech & Pfizer's vaccine.	O	O	O	O	O

[S2_q12–28] To what extent do you agree with the following statement?

	I fully agree	I rather agree	I rather disagree	I fully disagree	Neither
I think most of my closest circle of relatives and friends are getting vaccinated against COVID-19.	O	O	O	O	O
I think my closest circle of relatives and friends expect me to get vaccinated against COVID-19.	O	O	O	O	O
Society expects me to get vaccinated against COVID-19.	O	O	O	O	O
It is better for me to get vaccinated against COVID-19.	O	O	O	O	O
It is better for my relatives and friends if I get vaccinated against COVID-19.	O	O	O	O	O
It is better for society if I get vaccinated against COVID-19.	O	O	O	O	O
I completely trust the COVID-19 vaccine.	O	O	O	O	O
All in all, I feel well-informed about the COVID-19 vaccine.	O	O	O	O	O
If many others get vaccinated, then I will get vaccinated as well.	O	O	O	O	O
I would like to be vaccinated only after seeing that others have not experienced severe side effects.	O	O	O	O	O
If many others get vaccinated, I do not need to be vaccinated as well.	O	O	O	O	O
The expectations of my relatives and friends are important for my own vaccination decision.	O	O	O	O	O
I am in favor of giving vaccinated people legal advantages (e.g., being allowed to go to restaurants or fly without testing).	O	O	O	O	O
I am in favor of punishing individuals who refuse a COVID-19 vaccination (e.g., by restricting their freedom to travel or banning them from certain professions).	O	O	O	O	O
The COVID-19 vaccination should be mandatory for all.	O	O	O	O	O
I recommend that other people get vaccinated against COVID-19.	O	O	O	O	O

[End of experimental variation:]

[S2_q29] It sometimes happens that survey participants do not read individual questions accurately. To ensure that you read the questions accurately, we ask you to ignore the following question and enter the number twenty-two in the text box.

The federal states are responsible for organizing vaccination against Corona. In how many states do you estimate that primary care physicians are already providing vaccination nationwide?

In _____ of the total of 16 federal states

[Cooperation-Game[ii]]

[ii] At this stage, we ran an incentivized one-shot Prisoner Dilemma game. For detailed instructions please refer to Angerer et al. (2022a).

[S2_q30] Have you already been vaccinated against COVID-19?

- o Yes, I have received at least one dose
- o No

[S2_q31] Have you already been infected with COVID-19?

- o Yes, for sure
- o Yes, I think so
- o No, I don't think so
- o No, definitely not

[S2_q32] Do you have a profession in the health sector? (e.g. nurse, doctor, pharmacist)

- o Yes
- o No

[If "Yes" → [S2_q32f] What is your profession? - open answer question]

[S2_q33] Do you practice a profession in a so-called system-relevant profession? (e.g., in a health profession incl. care of the elderly, at the public health department, at the police or fire department)

- o Yes
- o No

[S2_q34] Do you think you belong to the group of people who are at increased risk for severe disease progression from COVID-19 disease?

- o Yes, for sure
- o Yes, I think so
- o No, I don't think so
- o No, definitely not
- o I don't know

[S2_q35] Do you have regular close contact with individuals who are at increased risk for severe disease progression from COVID-19 disease?

- o Yes
- o No

[S2_s06] How do you rate yourself personally? Are you generally a risk-taker or do you try to avoid taking risks?

Please tick a box on the scale, where the value 0 means "not at all willing to take risks" and the value 10 means "very willing to take risks". You can use the values in between to grade your assessment.

Not at all risky										Very risky
O	O	O	O	O	O	O	O	O	O	O

[S2_s07] Are you someone who is generally willing to give up something today to benefit from it in the future, or are you not willing to do so?

Please tick a box on the scale, where a value of 0 means "not at all willing" and a value of 10 means "very willing". You can use the values in between to grade your assessment.

Not at all										Very
O	O	O	O	O	O	O	O	O	O	O

[S2_s08] Are you someone who is generally willing to share with others without expecting anything in return, or are you unwilling to do so?

Please tick a box on the scale, where a value of 0 means "not at all willing" and a value of 10 means "very willing". You can use the values in between to grade your assessment.

Not at all										Very
O	O	O	O	O	O	O	O	O	O	O

[S2_s09–11] How much trust do you have...

	Very high trust	High trust	Little trust	No trust at all
... in other people?	O	O	O	O
... in the government?	O	O	O	O
... in science?	O	O	O	O

[S2_s12] Were you born in Germany?

- o Yes
- o No

[S2_s13] Many people in Germany tend to vote for a particular political party in the long term, even if they occasionally vote for another party. Which party do you generally sympathize with?

- o CDU or CSU
- o SPD
- o AfD
- o FDP
- o Die Linke
- o Bündnis90/Die Gruenen
- o Another party, namely _____
- o None

[S2_s14] What is the best way to describe your acquisition situation?

- o Pupil, trainee, student
- o Full-time employed (incl. short-time work)
- o Part-time employed (incl. short-time work)
- o Self-employed
- o Unemployed
- o Househusband/housewife
- o In retirement, pension or early retirement
- o Other employment situation, namely _____

[S2_s15] How many people currently live with you in a household - including yourself

_____ adults (18 years and older)
_____ children (under 18)

[S2_s16] What is the total monthly net income of your household?
This means the sum resulting from wages, salary, income from self-employment, pension, or retirement pension, in each case after deduction of taxes and social security contributions. Please also include income from public assistance, income from renting, leasing, housing allowance, child benefit, and other income.

- o below 400 Euro
- o 400 until below 500 Euro
- o 500 until below 750 Euro
- o 750 until below 1.000 Euro
- o 1.000 until below 1.250 Euro
- o 1.250 until below 1.500 Euro
- o 1.500 until below 1.750 Euro
- o 1.750 until below 2.000 Euro
- o 2.000 until below 2.250 Euro
- o 2.250 until below 2.500 Euro
- o 2.500 until below 2.750 Euro
- o 2.750 until below 3.000 Euro
- o 3.000 until below 3.250 Euro
- o 3.250 until below 3.500 Euro
- o 3.500 until below 3.750 Euro

- o 3.750 until below 4.000 Euro
- o 4.000 until below 5.000 Euro
- o 5.000 Euro and more

[S2_s17] What is the postal code of your place of residence?

[S2_q36]: What do you guess is the percentage of the adult population in Germany who agree with the following statement?

"I will get vaccinated against COVID-19 as soon as a vaccine is available for me."
(If you have already been vaccinated, please put yourself in the situation as if you have not yet been vaccinated).

- o I fully agree
- o I rather agree
- o I rather disagree
- o I fully disagree
- o Neither

_____ of 100 Germans agree "fully" or "rather" with the statement.

[S2_q36s] How confident are you that your answer is approximately correct?

Very unconfident						Very confident
O	O	O	O	O	O	O

[only respondents in ***Norm Info***: S2_q37]: We gave you information on vaccination readiness from a previous survey at the beginning of the questionnaire, and that is that 70 out of 100 respondents agreed with the statement "I will get vaccinated against COVID-19 as soon as a vaccine is available for me."

How trustworthy did you find this information?

Very untrustworthy						Very trustworthy
O	O	O	O	O	O	O

[q38] If you have any comments, criticisms, or suggestions for improvement regarding the survey, please use this text field.

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Silvia Angerer, Daniela Glätzle-Rützler, Philipp Lergetporer, and Thomas Rittmannsberger

Beliefs about social norms and (the polarization of) COVID-19 vaccination readiness

Abstract
Social norms affect a wide range of behaviors in society. We conducted a representative experiment to study how beliefs about the existing social norm regarding COVID-19 vaccination affect vaccination readiness. Beliefs about the norm are on average downward biased, and widely dispersed. Randomly providing information about the existing descriptive norm succeeds in correcting biased beliefs, thereby reducing belief dispersion. The information has no effect on vaccination readiness on average, which is due to opposite effects among women (positive) and men (negative). Fundamental differences in how women and men process the same information are likely the cause for these contrasting information effects. Control-group vaccination intentions are lower among women than men, so the information reduces polarization by gender. Additionally, the information reduces gendered polarization in policy preferences related to COVID-19 vaccination.

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