The association between vaccination status identification and societal polarization

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Public discord between those vaccinated and those unvaccinated for COVID-19 has intensified globally. Theories of intergroup relations propose that identifying with one's social group plays a key role in the perceptions and behaviours that fuel intergroup conflict. We test whether identification with one's vaccination status is associated with current societal polarization. The study draws on panel data from samples of vaccinated (n = 3,267) and unvaccinated (n = 2,038) respondents in Germany and Austria that were collected in December 2021 and February, March and July 2022. The findings confirm that vaccination status identification (VSI) explains substantial variance in a range of polarizing attitudes and behaviours. VSI was also related to higher psychological reactance toward mandatory vaccination policies among the unvaccinated. Higher levels of VSI reduced the gap between intended and actual counterbehaviours over time by the unvaccinated. VSI appears to be an important measure for predicting behavioural responses to vaccination policies.

While COVID-19 vaccines have been widely available in many countries for some time, a substantial proportion of people remain unvaccinated[1]. As uptake slowed down despite the availability of vaccines, public discourse around the issue intensified, prompting calls for mandatory vaccination in many countries. Thousands of people have participated in public demonstrations both for and against vaccination and, more specifically, for and against associated mandates[2]. As this situation is unfamiliar, little is known about what causes people to join one of these polarized camps.

How can we explain this shift from relating to one's own vaccination status as an individual and private identity to a publicly shared group identity involving collective action intentions? Some researchers have argued that individual vaccination status can become an important part of people's identity[3] and identification with these social groups has probably increased for some during the long-lasting pandemic, which has had (and continues to have) a great impact on people's lives[4,5]. Moreover, belonging to one group or the other has had real-world impacts in many countries, for example, due to access restrictions based on vaccination status.

Research on opinion-based groups shows that social groups can form around shared attitudes[6,7]. While, in the real-world, groups often cluster on the basis of sociodemographic characteristics, opinion-based groups can profit especially from online interaction[8]. According to social identity theory[9,10], individuals use their group memberships to define who they are (their self-concept) and to determine what to think and how to behave. The related self-categorization theory[11] proposes that social categories are represented as a set of attributes that capture similarities within and differences between groups, including the groups' values, norms and behaviours. In the context of vaccination and related policies, this could include, for instance, values related to belief in science, freedom to make one's own decisions or trust in certain media. According to these prominent

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theoretical perspectives, people tend to view their own social groups (ingroups) as distinctive and superior to other groups (outgroups) and engage in behaviours that confirm this belief. Thus, strong group identification can fuel intergroup conflict. Such conflict may unfold in terms of how people perceive ingroup and outgroup members and how they actually behave in their interactions with ingroup and outgroup members[12]. Furthermore, individuals' group identification could determine how they respond to different situations that threaten their ingroup's status[13]. For example, previous research on the polarization of the American electorate has shown that partisans discriminate against opposing partisans (threatening their status) to a degree that exceeds discrimination based on race[14].

Using this strong theoretical basis, the present studies tested the fundamental idea that identification with one's vaccination status is a crucial factor in the polarization of related attitudes and behaviours. Using correlational analysis, we provide evidence on the extent of people's identification and its association with measures of societal polarization. We collected panel data from Germany and Austria ($n = 5,305$) in three waves (December 2021, February 2022 and July 2022; plus an additional data collection with a subsample in March 2022) to investigate the correlates and consequences of what we label "vaccination status identification" (VSI). In the total sample, 62% indicated themselves to be vaccinated in December 2021. Compared to the adult German (GER) and Austrian (AUT) populations[15–20], our sample was slightly younger ($Mean(M)_{\text{Sample}}$ AUT = 44.5 yr, $M_{\text{Population}}$ AUT = 49.6 yr, M_{Sample} GER = 47.6 yr, $M_{\text{Population}}$ GER = 51.3 yr), roughly balanced across genders (sample AUT 53.3% female, population AUT 51.3%; sample GER 53.0%, population GER 51.1%), more educated (sample AUT 48.4% have university entrance qualification, population AUT 44.1%; sample GER 53.1%, population GER 37.0%) and roughly similar in their likelihood to be employed (sample AUT 60.2%, population AUT 60.7%; sample GER 61.9%, population GER 58.2%). The timing of the studies is unique, as in both countries data were collected during heated public debates about the value of vaccination and different vaccination policies, such as vaccination mandates.

Results and discussion

Measurement and correlates of VSI

To measure VSI, we adapted five items from established group identification scales (for example, "I am proud (not) to be vaccinated against COVID-19")[21,22]. The items were chosen to capture different dimensions of group identification without needing to assess a large number of items as required by established scales. Data from March 2022 showed that VSI was strongly related to other (broader or more specific) social identification measures developed by ref. [23] ($r = 0.79$, confidence interval (CI) = [0.75, 0.82]) and ref. [21] ($r = 0.72$, CI = [0.68, 0.76]). As further indicators of the validity of VSI, we assessed typical intergroup phenomena that should be stronger with greater identification with one's own group. Indeed, when rating the distinctiveness of the groups of vaccinated and unvaccinated people, higher levels of VSI were positively correlated with greater perceived intergroup differences for both vaccinated ($r_{\text{vaccinated}} = 0.41$, CI = [0.30, 0.51]) and unvaccinated individuals ($r_{\text{unvaccinated}} = 0.29$, CI = [0.17, 0.40]). In contrast (and as preregistered at https://aspredicted.org/nn2as.pdf), both groups perceived members of their respective ingroup to be more similar to each other the higher VSI was ($r_{\text{vaccinated}} = 0.59$, CI = [0.50, 0.66]; $r_{\text{unvaccinated}} = 0.52$, CI = [0.43, 0.61]). Outgroup members were also perceived to be more similar to each other as respondent's VSI increased, although this result was more noticeable among unvaccinated ($r_{\text{unvaccinated}} = 0.23$, CI = [0.11, 0.35]) than among vaccinated respondents ($r_{\text{vaccinated}} = 0.08$, CI = [−0.05, 0.20]).

Additionally, VSI proved sufficiently distinct from vaccination intention and vaccine-related feelings and beliefs. The latter were measured using the 7C scale of vaccination readiness[24], which includes confidence in vaccines, complacency, calculation, constraints, collective responsibility, compliance and conspiracy thinking.

The following correlations refer to December 2021 but did not change qualitatively in later data collection timepoints (Supplementary Table 1). Among unvaccinated individuals, correlations between VSI and the 7C ranged between −0.28 (for confidence in vaccines) and 0.39 (for conspiracy thinking); the correlation with vaccination intention was −0.26. Among vaccinated individuals, correlations between VSI and the 7C ranged between −0.64 (for the perception of constraints) and 0.58 (for collective responsibility); the correlation with their intention to receive a booster shot was 0.50. Taken together, the validation results indicate that: (1) VSI is indeed well described as a group identity among the vaccinated and the unvaccinated in the context of the COVID-19 pandemic and (2) VSI is empirically related but conceptually different from other vaccination-related perceptions and behavioural intentions.

In December 2021, mean VSI was medium to high and varied considerably between individuals, with somewhat higher overall levels among the vaccinated ($M = 4.74$, s.d. = 1.36) than among the unvaccinated ($M = 4.36$, s.d. = 1.25, $t(4,582.60) = 10.42$, $P < 0.001$, $d = 0.29$, CI = [0.24, 0.35]). Similar levels were found in February and July 2022 (Supplementary Fig. 1). The (small) difference between vaccinated and unvaccinated people appears plausible given that group membership is more likely to change for the unvaccinated as they are able to change their vaccination status and, thus, their group identity. Indeed, for participants whose vaccination status did not change over time, VSI was remarkably stable (correlation between December 2021 and July 2022: $r_{\text{vaccinated}} = 0.67$, CI = [0.65 0.69]; $r_{\text{unvaccinated}} = 0.57$, CI = [0.53, 0.61]). Participants who decided to get vaccinated between December 2021 and July 2022 ($n = 144$) showed lower levels of VSI in December ($M = 3.81$, s.d. = 1.33) compared to unvaccinated participants who did not get vaccinated and thus did not change their group membership ($M = 4.51$, s.d. = 1.25, $t(173.90) = 5.79$, $P < 0.001$, $d = 0.52$, CI = [0.34, 0.70]). Unvaccinated individuals' VSI in December 2021 was thus predictive of their subsequent likelihood of vaccine uptake—the lower their previous VSI, the higher the likelihood of getting vaccinated.

Potential predictors of VSI were explored separately for vaccinated and unvaccinated participants in December 2021 by using regression analyses including sociodemographic variables, news consumption behaviours, trust in the government and perceptions of social norms around vaccination. Among the vaccinated, individuals were found to identify more strongly with their vaccination status when they were older ($\beta = 0.19$, $b = 0.01$, CI = [0.01, 0.01]), trusted the government more ($\beta = 0.29$, $b = 0.17$, CI = [0.14, 0.19]), when they reported that people important to them were vaccinated (descriptive norm to be vaccinated; $\beta = 0.10$, $b = 0.09$, CI = [0.04, 0.14]) and, most notably, when they assumed that people important to them thought that one should be vaccinated (injunctive norm to be vaccinated; $\beta = 0.34$, $b = 0.25$, CI = [0.20, 0.30]). VSI was also stronger among those who reported searching more frequently for COVID-19-related information ($\beta = 0.21$, $b = 0.14$, CI = [0.11, 0.17]). Left-wing voters identified less with being vaccinated than centrists ($b = −0.10$, CI = [−0.21, 0.00]) and the same was true for right-wing voters ($b = −0.30$, CI = [−0.42, −0.12]) and non-voters ($b = −0.33$, CI = [−0.43, −0.23]).

The unvaccinated identified more strongly with being unvaccinated when they did not perceive a descriptive norm to be vaccinated ($\beta = −0.14$, $b = −0.08$, CI = [−0.13, −0.04]), when they trusted the government less ($\beta = −0.18$, $b = −0.15$, $CI = [−0.20, −0.09]$), when they claimed to vote for right-wing parties rather than centrist parties ($b = 0.36$, CI = [0.17, 0.55]) and when they consumed less information from traditional news sources, such as TV, radio, newspapers or government websites ($\beta = −0.13$, $b = −0.46$, CI = [−0.67, −0.25]) and instead consumed more information from alternative sources, such as social media and messaging services ($\beta = 0.16$, $b = 0.62$, CI = [0.40, 0.84]). Importantly, the results of both regression analyses remained qualitatively unchanged when controlling for vaccination intention and the 7C scale (Supplementary Table 2).
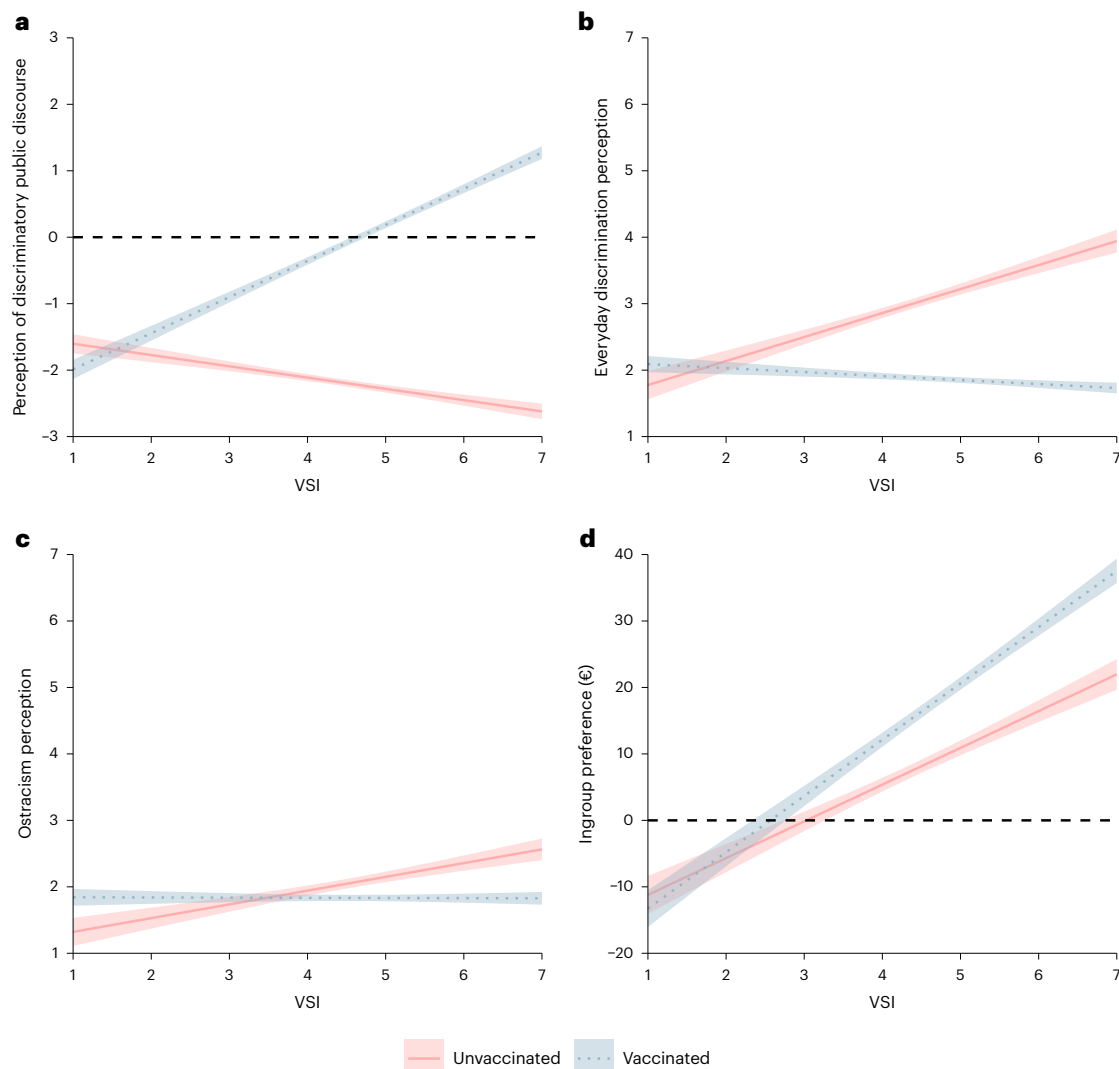
Fig. 1 | Effects of VSI on perceptions of public discourse and discrimination. **a**–**d**, Linear regression analyses of VSI, vaccination status and their interaction, predicting: perceptions of public discourse (average of three 7-point scales ranging from unfair, moralistic and patronizing to fair, objective and respectful; data from December 2021), $R^2 = 0.46$ (**a**); perceptions of everyday discrimination (mean of five items measured on 7-point scales; higher values indicate more discrimination, data from December 2021), $R^2 = 0.16$ (**b**); perceptions of being ostracized (mean of four items measured on 7-point scales; higher values indicate being more ostracized, data from February 2022), $R^2 = 0.02$ (**c**); ingroup preference in two dictator games (positive values indicate greater ingroup preference, that is discrimination of the outgroup, data from December 2021), $R^2 = 0.16$ (**d**). Lines represent the linear fit, with ribbons visualizing 95% CI. The pattern of results did not change qualitatively when controlling for sociodemographic variables and the 7C scale (Supplementary Tables 3–6).

Perceptions of public discourse and discrimination

According to previous research[25], vaccination is perceived as a social contract. Because it has positive consequences for others, those who get vaccinated (and comply with the contract) tend to treat others who also comply more favourably than unvaccinated (non-compliant) others. Importantly, the vaccinated also tend to punish unvaccinated others[25–27], which can be interpreted as a manifestation of conflict and polarization. In line with this tendency, in December 2021, 82% of the unvaccinated perceived public discourse around vaccination as unfair, moralistic and patronizing, while only 23% of the vaccinated reported feeling this way. Importantly, this perception was moderated by VSI (Fig. 1a); higher levels of VSI were associated with perceiving the public discourse as more positive among the vaccinated but as more negative among the unvaccinated. The results were similar for general perceptions of being discriminated against, as measured by a short five-item version of the everyday discrimination scale (for example, "Other people act as if I am not intelligent")[28]. Among vaccinated individuals,

average perceived discrimination was low (December 2021: $M = 1.87$, s.d. = 1.22); among the unvaccinated, it was higher ($M = 2.99$, s.d. = 1.76, $t(3,259.70) = 25.23$, $P < 0.001$, $d = 0.74$, CI = [0.68, 0.80]) and increased with VSI (Fig. 1b). The same pattern was found for severe forms of discrimination measured with the ostracism short scale[29] in February 2022 (for example, "Others exclude me from conversations"). While perceived ostracism was low in both groups, unvaccinated individuals ($M = 2.03$, s.d. = 1.45) had experienced slightly more social exclusion than vaccinated participants ($M = 1.83$, s.d. = 1.27, $t(2,705.90) = 4.59$, $P < 0.001$, $d = 0.15$, CI = [0.09, 0.21]). Importantly, ostracism was not related to VSI among the vaccinated but was found to be positively related among the unvaccinated (Fig. 1c).

To investigate whether perceived discrimination had any factual basis, participants were asked to play two dictator games. They were asked to distribute €100 between themselves and a vaccinated person (game 1) or an unvaccinated person (game 2, randomized order). Ingroup preference was measured as the difference between
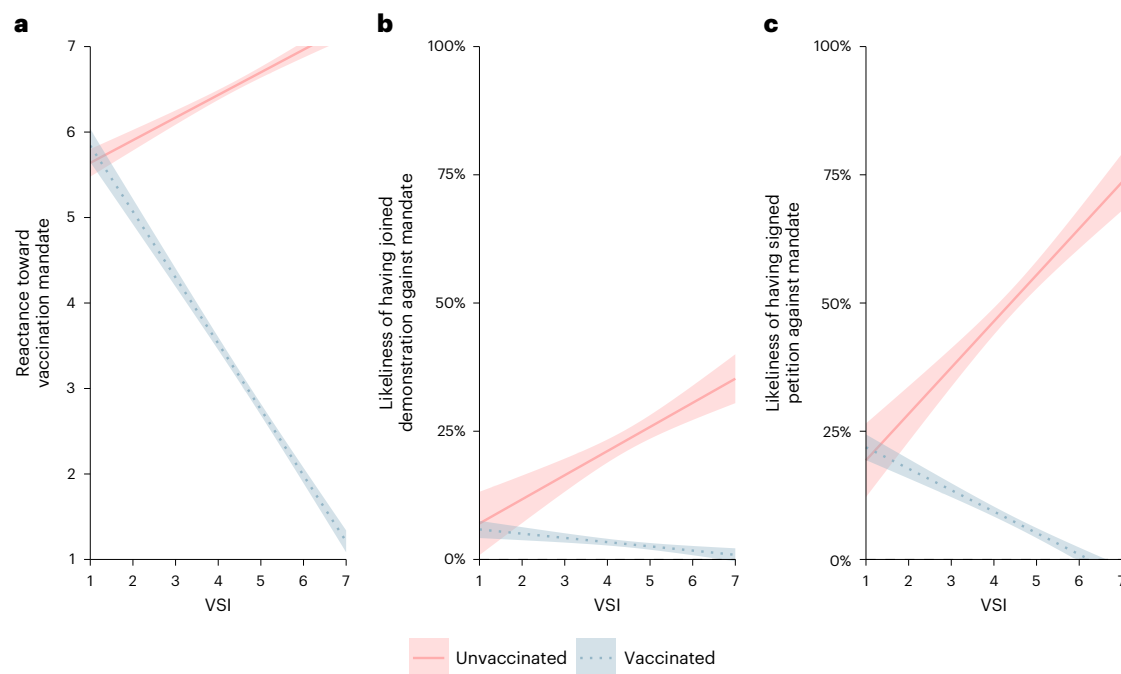
Fig. 2 | Effects of VSI on reactance toward mandatory policies and activism behaviour. a–c, Linear regression analyses of VSI, vaccination status and their interaction, predicting: psychological reactance to a hypothetical vaccination mandate (measured by anger assessed on a 7-point scale, data from December 2021), $R^2 = 0.56$ (**a**); whether participants reported demonstrating against a vaccination mandate since January 2022 (binary variable, data from February 2022), $R^2 = 0.12$ (**b**); and whether participants reported signing a petition against a vaccination mandate since January 2022 (binary variable, data from February 2022), $R^2 = 0.28$ (**c**). The pattern of results did not change qualitatively when controlling for sociodemographic variables, the 7C and, in the case of **a**, further experimental manipulations (Supplementary Tables 7–9). Lines represent the linear fit, with ribbons visualizing 95% CI.

the distributed amounts and indicated the strength of discrimination. The games were conducted in December 2021 and repeated in February and July 2022. At all three timepoints, the average ingroup preference of vaccinated individuals (December 2021: $M = €18.40$, s.d. $= €29.80$) was higher compared to unvaccinated participants ($M = €7.37$, s.d. $= €23.90$, $t(4,981.00) = 14.86$, $P < 0.001$, $d = 0.41$, CI $= [0.35, 0.47]$). While vaccinated and unvaccinated individuals granted comparable amounts to ingroup members (December 2021: $M_{vaccinated} = €48.06$, s.d.$_{vaccinated} = €23.83$, $M_{unvaccinated} = €45.93$, s.d.$_{unvaccinated} = €25.11$, $t(4,151.40) = 3.07$, $P = 0.002$, $d = 0.09$, CI $= [0.03, 014]$), vaccinated participants gave considerably less money to outgroup members than did unvaccinated individuals ($M_{vaccinated} = €29.66$, s.d.$_{vaccinated} = €26.55$, $M_{unvaccinated} = €38.56$, s.d.$_{unvaccinated} = €25.30$, $t(4,478.10) = 12.23$, $P < 0.001$, $d = 0.34$, CI $= [0.28, 0.40]$). Furthermore, ingroup preference among the unvaccinated increased with VSI and this effect was even stronger among vaccinated individuals (Fig. 1d). Thus, the more vaccinated people identified with being vaccinated, the more they discriminated against unvaccinated players. The unvaccinated also did this but to a smaller extent. The stronger discrimination behaviour of vaccinated individuals matches the finding that perceptions of being discriminated against were reported more frequently by unvaccinated people. This suggests that reports of discrimination are not fiction but fact.

The role of VSI in vaccination policy acceptance

Previous research suggests that low vaccination intentions predict psychological reactance to mandatory vaccination policies, eliciting behaviours that oppose such regulations[30,31]. However, there are also some vaccinated people who oppose such mandates[32]. To better understand the relationship between vaccination status and reactance to mandatory vaccination, we investigated the potential moderating role of VSI. In December 2021, we conducted a between-participants experiment in which participants were asked to imagine that a vaccination mandate would be enforced in the near future. As public discussions

loomed around various policy drafts in both Germany and Austria at that time, the experimental conditions took up these discussions and accordingly varied the affected age groups (mandating vaccination for people aged 12 yr and older versus 18 yr and older) and sanctions in case of non-vaccination (fine versus fine and work bans). Reactance was measured with a single item asking the participants how angry they were about the described mandate.

In line with previous research[30], average reactance toward mandatory vaccination was stronger for unvaccinated ($M = 6.53$, s.d. $= 1.34$) than for vaccinated individuals ($M = 2.96$, s.d. $= 2.19$, $t(5,301.30) = 73.75$, $P < 0.001$, $d = 1.97$, CI $= [1.88, 2.07]$). Linear regression analysis revealed that the effect of vaccination status was moderated by VSI (Fig. 2a); when VSI was low (that is, people did not identify with their vaccination status), both vaccinated and unvaccinated individuals reported high levels of reactance. When VSI was high, reactance was even greater among the unvaccinated but smaller among the vaccinated. This interaction effect was independent of the manipulated factors (mandated age group and sanctions). Reactance correlated strongly with intended behaviours opposing the mandate, including signing a petition ($r = 0.81$, CI $= [0.80, 0.82]$), joining a demonstration ($r = 0.66$, CI $= [0.65, 0.68]$) and mobilizing others to fight the mandate ($r = 0.67$, CI $= [0.65, 0.68]$). This supports the view that VSI plays an important role in societal polarization as a response to vaccination policies. Higher levels of reactance were also strongly related to the intention to avoid vaccination if it became mandatory ($r = 0.76$, CI $= [0.74, 0.77]$).

While we only assessed intentions to engage in activism against the mandate in December 2021, we explored the link between VSI and actual behaviour reported in February 2022. Specifically, we asked participants whether they had participated in a demonstration or signed a petition against the introduction of vaccination mandates since the beginning of 2022. For low levels of VSI, we found that similar fractions of vaccinated and unvaccinated were involved in demonstrations (Fig. 2b) or signing petitions (Fig. 2c). However, for high levels of VSI,

we found polarized behaviour: the fractions strongly increased for the unvaccinated, while they decreased for vaccinated individuals. Using the panel structure, we further investigated whether those individuals who indicated that they would demonstrate against mandatory vaccinations or sign a petition in December 2021 actually reported having done so in February 2022 and whether this link was influenced by VSI (as measured in December 2021). Indeed, intention was found to predict behaviour ($r_{demonstration}$ = 0.46, CI = [0.43, 0.48]; $r_{petition}$ = 0.55, CI = [0.53, 0.57]). A regression analysis investigating the effects of intention, VSI and their interaction on behaviours of unvaccinated individuals revealed that behaviour was more likely when intention was high (demonstration: β = 0.40, b = 0.04, CI = [0.01, 0.06]; petition: β = 0.33, b = 0.05, CI = [0.01, 0.08]). The effect was moderated by VSI, with higher identification increasing the effect of intention on behaviour (demonstration: β = 0.05, b = 0.01, CI = [0.01, 0.01]; petition: β = 0.05, b = 0.01, CI = [0.02, 0.02]).

Discussion

The findings indicate that the strength of identifying with one's vaccination status is associated with several measures of polarization of the current debate on COVID-19 vaccination. VSI accounts for much of the variance between vaccinated and unvaccinated individuals' perceptions of public discourse, factual and perceived discrimination, as well as the quality and strength of their responses to mandatory vaccination policies. While our results do not allow for causal interpretation, stronger VSI was associated with greater discrimination against people whose vaccination status differed. Interestingly, the tendency to discriminate was especially pronounced among vaccinated participants. This may be explained by other findings, indicating that vaccination is perceived as a social contract among vaccinated people where violating this social contract by not getting vaccinated is more harshly punished by vaccinated people than conforming to it is punished by unvaccinated people[25–27]. Stronger VSI was also found to be related to higher psychological reactance to mandatory vaccination policies among the unvaccinated and to their intentions and actions to resist and evade such regulations. As VSI also related to patterns of traditional and social media use, political preferences and differences in perceived social norms, it seems plausible that the unvaccinated and vaccinated constitute coherent and distinct social clusters ("bubbles")[33], which can be seen as a further catalyst of group conflict.

The results presented in this article have some limitations. First, the sample is not representative of the German or Austrian populations. Collecting data from thousands of unvaccinated individuals meant to lift sampling requirements. While the demographics show considerable variance (Supplementary Table 10), generalization may still be limited. For instance, while similar to the German and Austrian adult population with respect to gender and employment, our sample is younger and more educated. Second, our design and analyses are correlational and causal interpretations are not possible. For instance, we cannot conclude that VSI drives discrimination; instead, the relationship could also work in the other direction or be bidirectional. Future experimental research should investigate these relationships by manipulating VSI in experimental settings. Third, all variables were self-reported and may have differed from the respondents' actual behaviours. For instance, unvaccinated participants may have exaggerated their intentions to avoid vaccination in the case of mandatory policies.

Despite these limitations, the results suggest that VSI may be important to understanding when a private and personal vaccination decision can become an important aspect of group membership that defines people's self-concept. While group processes have been assumed to be relevant when discussing antivaccination attitudes among anthroposophical parents[34], this study reveals strong correlates of identification with being (not) vaccinated in a general population convenience sample. The current data extend the theoretical perspective on vaccination behaviour and its societal consequences and can

help predict people's behaviours both within and outside of the health sector. Three key examples demonstrate this. First, unvaccinated individuals with lower levels of VSI in December 2021 were more likely to be vaccinated in July 2022. Second, unvaccinated individuals with higher levels of VSI were more likely to translate their intentions of performing counterbehaviours related to vaccination policies (for example, attending demonstrations) into actual behaviours. Third, in unrelated money games, unvaccinated people were discriminated against by vaccinated people (and vice versa). Given the importance of these behaviours and what they represent for society in the context of the current pandemic (vaccine uptake, counterbehaviours in response to vaccination policies and polarization), VSI appears to be a useful concept that should be considered in future research.

The findings also have practical implications. While a shared social identity is known to act as a buffer against stress from COVID-19-related threats[35], our findings highlight the potential negative consequences of strongly identifying with one's vaccination status. Besides being associated with polarization and potential conflicts between vaccinated and unvaccinated groups, VSI may also impede the success of vaccination campaigns. Appeals to identify with vaccination or a vaccinated society may thus backfire. For instance, such campaigns might increase VSI of vaccinated individuals, who potentially increase their discriminatory behaviour toward unvaccinated individuals. According to previous research on rejection identification processes[36,37], discrimination against unvaccinated people, in turn, might increase their identification with non-vaccination, lowering vaccination intentions even more and further fuelling societal polarization. Talking about vaccination as a simple health intervention may be more successful. These possibilities should be explored in further research once a causal role for VSI has been established. Previous research indicates that maintaining procedural fairness, for example, by government officials treating vaccinated and unvaccinated individuals in a fair, respectful and neutral way, can emphasize the inappropriateness of aggressive interactions and decrease discrimination and ostracism behaviours[38]. While such measures may not increase vaccination rates directly, they could help de-escalate the situation and provide a new basis for discussing and implementing effective and acceptable vaccination policies in the future. In this vein, the rationale behind vaccination mandates could be revisited in public discussions. While sanctions can increase vaccine uptake[39], mandatory regulations may also curb polarization. When individuals become vaccinated to avoid penalties, they cease to be part of the unvaccinated and their identification with this group should subsequently decrease. Similarly, and somewhat counterintuitively, we speculate that mandating vaccinations could help reduce the identification of those who have been vaccinated for a long time. Vaccination will then not be something that expresses individual preferences. And once almost all people have been vaccinated due to mandatory regulations, one will be unable to separate oneself from others with regard to vaccination status and being vaccinated will consequently become a less important part of one's self-concept. In this way, effective (enforced) mandates could not only help to end the pandemic but also mitigate conflicts between vaccinated and unvaccinated groups, thereby fostering social cohesion.

Methods

The present data were collected in three longitudinal waves: (1) 15–27 December 2021, (2) 11–23 February 2022 and (3) 30 June–12 July 2022. There was an additional data collection with a subsample conducted 14–18 March 2022. During these times, infection numbers were high in Germany (with a peak of 297.845 new infections on 18 March 2022) and Austria (with a peak of 51.951 new infections at the same date) and discussions about the introduction of mandatory vaccinations loomed.

Participants

In the first wave (December 2021), the panel included n = 5,305 participants from Germany (2,003 vaccinated and 1,230 unvaccinated)

and Austria (1,264 vaccinated and 808 unvaccinated). To recruit as many unvaccinated individuals as possible, sociodemographic sampling requirements were lifted. Participants were 18 to 99 years old (M = 46.42 yr, s.d. = 16.78, with a negligible difference between the vaccinated and unvaccinated, d = 0.06). Of these 53% were female and most participants (51%) indicated high education status (having university entrance qualifications).

In the second wave (February 2022), 4,406 of the original participants (83%) participated again (2,906 vaccinated and 1,500 unvaccinated). Between the first and second wave, 126 participants were vaccinated for the first time.

In the third wave (July 2022), 3,660 of the original participants (69%) participated again (2,442 vaccinated and 1,218 unvaccinated). Between the second and third wave, a further 18 participants were vaccinated for the first time.

In an additional data collection (March 2022), a randomly selected subset of 600 participants from the second wave was invited to participate to validate the VSI measure. In total, 498 participated, with 249 being vaccinated and 249 unvaccinated at the time of data collection.

Ethical compliance
The study was conducted in accordance with German Psychological Association guidelines. Ethical clearance was obtained from the University of Erfurt's institutional review board (no. 20211215) and all participants provided informed consent to use and share their data for scientific purposes without disclosure of their identities. Participants were compensated for their participation by the panel provider.

Materials and measures
For all materials and survey questions, participants were told that being vaccinated referred to having received at least one dose of an approved COVID-19 vaccine.

First wave (December 2021)
All measures were assessed in the order of appearance.

Voting preferences. Participants were asked which political party best represents them. Depending on the country, participants could choose a party from a list of German or Austrian parties or indicate that no party represents them. On the basis of their selection, participants were classified as left-, centre-, right- or non-voters. Note that when voting preferences are considered as predictors in regression analyses, no standardized estimates are presented in this article.

Information behaviour. Participants were asked how often they are searching for information about the coronavirus and COVID-19. Answers were recorded on a 7-point scale ranging from "never" to "very often".

Participants were also asked if they used various types of media to stay informed, including TV, radio, newspapers, news websites, governmental websites, social media (for example, Facebook and Instagram) and messengers (for example, WhatsApp and Telegram). Answers were recorded on binary scales ("used" or "not used").

Trust in the government. Participants were asked how confident they were that the federal government could handle the coronavirus properly. Answers were recorded on a 7-point scale, ranging from not at all to very much.

7C antecedents of vaccination. Antecedents of vaccination were measured using the short version of the 7C scale[24]. It included seven statements about confidence ("I am convinced the appropriate authorities do only allow effective and safe vaccines"), complacency ("I get vaccinated because it is too risky to get infected"), constraints ("Vaccinations are so important to me that I prioritize getting vaccinated over

other things"), calculation ("I only get vaccinated when the benefits clearly outweigh the risks"), collective responsibility ("I see vaccination as a collective task against the spread of diseases"), compliance ("It should be possible to sanction people who do not follow the vaccination recommendations by health authorities") and conspiracy beliefs ("Vaccinations cause diseases and allergies that are more serious than the diseases they ought to protect us from"). Participants were asked about their agreement on a 7-point scale ranging from "very strongly disagree" to "very strongly agree".

Vaccination intention
If the participants were unvaccinated, they were asked how likely they would be to get vaccinated if they had the chance to do so next week. If the participants were already vaccinated, they were asked how likely they would be to get a booster shot if it was available and recommended to them. Intentions were recorded on a 7-point scale, ranging from "not getting vaccinated at all" to "definitely getting vaccinated".

Social norms
Participants were asked about descriptive and injunctive vaccination norms using two items: "People who are important to me are vaccinated" and "People who are important to me think one should be vaccinated". Answers were recorded on a 7-point scale ranging from "nobody" to "everybody".

Perception of the public discourse
Participants were asked how they perceived the public discourse around vaccination using three 7-point items (1 to 7) with the poles unfair–fair, moralistic–objective and patronizing–respectful. Answers were mean-averaged and scores <3 were considered negative perceptions, while scores >5 were considered positive perceptions.

Discrimination perceptions
General discrimination perceptions were assessed using the everyday discrimination scale (Cronbach's α = 0.90)[28]. Participants were asked to indicate their agreement with five statements (for example, "Other people act as if I am not intelligent"). Answers were recorded on a 7-point scale ranging from "very strongly disagree" to "very strongly agree".

VSI. VSI was measured with five items adapted from established group identification scales[21–23]: (1) "I am proud (not) to be vaccinated against COVID-19"; (2) "When people are criticized for (not) being vaccinated against COVID-19, it feels like a personal insult to me"; (3) "I have little in common with people who have (not) been vaccinated against COVID-19" (reverse-coded); (4) "I have no problem telling others that I have (not) been vaccinated against COVID-19"; and (5) "If I learned that another person had (not) been vaccinated against COVID-19, I would directly feel more connected to that person". Answers were recorded on a 7-point scale ranging from "very strongly disagree" to "very strongly agree". We explicitly decided to create a new measure to capture different dimensions of group identification without the need to assess a large number of items as required by established scales like the social identification scale[22,23]. While internal consistency was acceptable (December 2021: Cronbach's α = 0.68), the scale was also successfully validated against other identification measures in an additional wave in March 2022 (see below).

Ingroup preference in dictator games. Participants were asked to distribute €100 between themselves and a vaccinated person (game 1) or an unvaccinated person (game 2, randomized order). The games were incentivized by the random selection of one decision by one participant for payout (in case the participant had assigned money to another person, this person was also selected randomly). Ingroup preference was measured as the difference between the amounts distributed to ingroup members and outgroup members.

Experiment on vaccination mandates. Participants were asked to imagine that a vaccination mandate would soon be enforced. Depending on the experimental condition, the mandate referred to different age groups (12 yr and older versus 18 yr and older) and entailed different sanctions (fine versus fine and work ban), resulting in a 2 × 2 between-subjects design. Participants were allocated randomly ($n_{12\,and\,older\,+\,fine} = 1{,}320$, $n_{18\,and\,older\,+\,fine} = 1{,}346$, $n_{12\,and\,older\,+\,fine\,and\,work\,ban} = 1{,}294$, $n_{18\,and\,older\,+\,fine\,and\,work\,ban} = 1{,}345$).

After receiving the information, participants were asked how much they supported the presented regulation and how angry they were about it (on a 7-point scale ranging from "not at all" to "very much"). The latter item was adapted from the Salzburg State reactance scale[40].

Furthermore, activism and avoidance intentions were assessed by asking participants if they would join a demonstration against the mandate, if they would sign a petition against it, if they would mobilize others to fight the regulation and if they would try to search for ways around the mandate. Answers to these four items were collected on a 7-point scale ranging from "not at all" to "definitively".

Finally, unvaccinated participants were asked if they would get vaccinated if the presented regulation came into force. Vaccination intentions were recorded on a 7-point scale ranging from "not getting vaccinated at all" to "definitively getting vaccinated".

Second wave (February 2022)
In the second wave, the measures from the first wave were assessed again, except for specific media usage and the experiment on vaccination mandates. Furthermore, ostracism experiences and activism behaviours were surveyed.

Ostracism experiences. Using the ostracism short scale[29], participants were asked how often they had experienced different forms of ostracism during the last 2 months (Cronbach's $\alpha = 0.93$; for example, "Others exclude me from conversations"). Answers were recorded on a 7-point scale ranging from "never" to "always".

Activism behaviour. Participants were asked if they had participated in a demonstration and if they had signed a petition against vaccination mandates since the beginning of 2022. The answers to both items were recorded on a binary scale ("yes" or "no").

Third wave (July 2022)
In the third wave, the measures from the first wave were assessed again, except for the experiment on vaccination mandates.

Additional wave with subsample (March 2022)
In this additional wave, a subsample of vaccinated and unvaccinated participants from the second wave was surveyed to validate the VSI measure (assessed as in the first and second waves) against the following identification scales.

Social identification scales. Participants were asked to indicate their agreement with 15 items of a social identification scale adapted from refs. [22,23]; example items: "(Not) being vaccinated against COVID-19 is an important part of how I see myself"; "I am a typical person who is (not) vaccinated against COVID-19". Answers were recorded on a 7-point scale ranging from "very strongly disagree" to "very strongly agree" (Cronbach's $\alpha = 0.95$).

Participants were also asked to indicate their agreement with four items adapted from the social identification scale developed by ref. [21]; example items: "I consider myself a member of the group that has (not) been vaccinated against COVID-19"; "I identify with the group that has (not) been vaccinated against COVID-19". Answers were recorded on a 7-point scale ranging from "very strongly disagree" to "very strongly agree" (Cronbach's $\alpha = 0.96$).

Perceived intergroup similarity. Participants were asked how similar they perceived the groups of vaccinated and unvaccinated people by selecting one of five figures showing two circles (representing the two groups) that had an overlap of 0–100%. Answers were coded from 1 to 5, with higher values indicating more intergroup similarity.

Perceived intragroup similarity. Using two items, participants were asked "How similar to each other are individuals that are (not) vaccinated against COVID-19"? Answers were recorded on a 7-point scale ranging from "not at all" to "very much".

Reporting summary
Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability
Materials and data are available at https://doi.org/10.17605/OSF.IO/6K4CW

Code availability
The data analysis script (including reported and supplemental analyses) is available at https://doi.org/10.17605/OSF.IO/6K4CW

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Author contributions

L.H., P.S., L.K., C.B. and R.B. designed the research. L.H. and P.S. performed the research and planned and performed data analysis. L.H. and P.S. wrote the initial draft, which was revised and approved by L.K., C.B. and R.B.

Competing interests

The authors declare no competing interests.

Additional information

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Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	The web platform Tivian (EFS Fall 2021) was used to collect the data.
Data analysis	The data analysis script (including reported and supplemental analyses) is available at https://dx.doi.org/10.17605/OSF.IO/6K4CW

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Human research participants

Policy information about <u>studies involving human research participants and Sex and Gender in Research.</u>

Reporting on sex and gender	Participant's self-reported gender (male/female/other) was assessed in the wave 1 questionnaire. It was considered a covariate in many analyses; however, all major findings did not depend on gender.
Population characteristics	See below
Recruitment	The panel provider recruited participants. As we do not know about the recruitment process in detail, there may be a self-selection bias; individuals with specific attitudes toward vaccination may have declined participation; furthermore, participation required a device with internet access (computer, mobile phone, tablet).
Ethics oversight	Ethical clearance was obtained from the University of Erfurt's institutional review board (#20211215).

Note that full information on the approval of the study protocol must also be provided in the manuscript.

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Behavioural & social sciences study design

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Study description	Quantitative panel study about attitudes and behaviors of individuals vaccinated or not vaccinated against COVID-19.
Research sample	We aimed at recruiting large groups of vaccinated and unvaccinated individuals. Therefore, sociodemographic sampling requirements were lifted. Wave 1 participants were 18 to 99 years old (M = 46.42, SD = 16.78). 53% were female, and most participants (51%) indicated high education status (i.e., having university entrance qualifications). While the sample can be considered diverse, it is not representative for the general German population.
Sampling strategy	Participants were invited and paid by a large panel provider (Bilendi AG). To find small effects in the planned analyses, we intended to collect data from about 3000 vaccinated and 3000 unvaccinated individuals. However, as recruiting unvaccinated individuals was difficult, data collection stopped after 12 days, resulting in 3267 vaccinated and 2,038 unvaccinated participants (first wave of the panel). While diverse with regard to multiple sociodemographic characteristics, the sample should be considered a convenience sample.
Data collection	Data was collected in an online survey. The researcher was blinded to experimental condition.
Timing	Wave 1: December 15-27, 2021 Wave 2: February 11-23, 2022 Wave 3: March 14-18, 2022 Wave 4: June 30-July 12, 2022
Data exclusions	No data were excluded
Non-participation	In wave 1, 2 participants declined participation (denied consent at the beginning of the survey) and 258 participants started but did not finish the survey (resulting in not recording their answers in the dataset); reasons for not finishing the survey were not recorded.
Randomization	Participants were allocated to experimental groups randomly.

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