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Discriminatory Attitudes Against the Unvaccinated During a Global Pandemic

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During the COVID-19 pandemic sizeable groups of unvaccinated minorities persist even in countries with high vaccine access[1]. Consequently, vaccination became a controversial subject of debate and even protest[2]. Here, we assess whether people express discriminatory attitudes in the form of negative affect, stereotypes and exclusionary attitudes in family and political settings across groups defined by COVID-19 vaccination status. We quantify discriminatory attitudes between vaccinated and unvaccinated citizens in 21 countries, covering a diverse set of cultures across the world. Across three conjoint experimental studies (N=15,233), we demonstrate that vaccinated people express discriminatory attitudes towards the unvaccinated, as high as the discriminatory attitudes suffered by common targets like immigrant and minority populations[3;4;5]. In contrast, there is an absence of evidence that unvaccinated individuals display discriminatory attitudes towards vaccinated people, except for the presence of negative affect in Germany and United States. We find evidence in support of discriminatory attitudes against the unvaccinated in all countries except Hungary and Romania and find that discriminatory attitudes are more strongly expressed in cultures with stronger cooperative norms. Prior research on the psychology of cooperation has shown that individuals react negatively against perceived free-riders[6;7] including in the domain of vaccinations[8;9]. Consistent with this, the present findings suggest that contributors to the public good of epidemic control (i.e., the vaccinated) react with discriminatory attitudes against perceived free-riders (i.e., the unvaccinated). Elites and the vaccinated general public appealed to moral obligations to increase COVID-19 vaccine uptake[10;11] but the present findings suggest that discriminatory attitudes including support for the removal of fundamental rights simultaneously emerged.

In a historical feat of science, highly effective vaccines against SARS-CoV-2 were developed, tested, approved, and mass produced in less than a year[12]. Soon, however, it became clear that achieving sufficiently high uptake of these vaccines was in itself a major challenge[13]. Despite targeted vaccine mandates, vaccine passports and massive information campaigns, sizeable groups in several countries across the world continued to refuse to get vaccinated against COVID-19, even where vaccines were widely available[1]. At the same time, many countries continued to employ interventions to control infection spread, resulting in feelings of "pandemic fatigue", waning support for restrictions, and dwindling trust in authorities[14;15;16].

Against this backdrop, public debates around COVID-19 have been heated. Some politicians have justified strict policies against the unvaccinated using highly moralistic rhetoric[10]. At the same time, disruptive public protests directed against vaccine mandates have taken place in several Western countries[2]. Survey research shows that divisions based on vaccination status are also emerging among the general public[17;18]. Individuals who comply with the advice of health authorities morally condemn the unvaccinated for violating a social contract in the midst of a crisis[11;8;9]. Those who refuse vaccines report that they feel discriminated[18] and pressured against their will[19]. Furthermore, vaccination status is consistently aligned with other political opinions such as trust in science and the authorities, and, in the case of the US, partisanship[13;20;9].

Prior research documents that political divides can poison everyday interactions between citizens by eliciting general antipathy in the form of prejudice[21]. Here, we provide a cross-cultural empirical investigation of the nature and level of prejudice across groups defined by COVID-19 vaccination status, covering in total 21 countries across all inhabited continents. We follow Crandall and Eshleman[22] and define prejudice as "a negative evaluation of an individual that is significantly based on the individual's group membership" (p. 414, see

also[23;24]). Prejudice can manifest itself in affective (e.g., negative emotions), cognitive (e.g., negative stereotypes) and attitudinal expressions (e.g., support for exclusion and discrimination) of prejudiced individuals[25]. Here, we investigate all three dimensions in the context of groups defined by COVID-19 vaccination status.

Research on the psychology of vaccination decisions prior to the COVID-19 pandemic[8] and prior to the implementation of COVID-19 vaccines[9] have shown that generosity in two-player behavioral economic games is indeed affected by the vaccination status of the players. Specifically, vaccinated individuals are less generous towards unvaccinated individuals but, importantly, unvaccinated are not less generous towards those vaccinated. These findings are interpreted on the basis of the psychology of human cooperation[8]. Research on cooperation has provided strong evidence that people monitor cooperative situations for the existence of free-riders (i.e., individuals who benefit from the cooperation without paying appropriate costs)[26] and react negatively towards free-riders upon detection[6;7]. Vaccinations contribute to the public good of epidemic control[27] and refusal to receive a vaccination is accordingly spontaneously perceived as an instance of free-riding, motivating contributors (i.e., the vaccinated) to withhold generosity from the unvaccinated[8]. As the spontaneous withholding of resources from the unvaccinated may incentivize vaccination, health communicators have been advised that "making the social contract explicit may help to increase vaccine uptake rates without relying on mandates"[8]. On most normative grounds, it is unproblematic if people – as shown in prior research – are generous only towards cooperators and withhold personal resources from strangers known to free-ride[28].

Yet, in highly polarized contexts such as vaccinations during the COVID-19 pandemic, it is possible that these psychological processes shift in multiple important ways beyond the findings of prior research on vaccination status and generosity. First, research on the

psychology of cooperation suggests that two distinct psychological motivations are activated in the context of public goods provisions: Motivations to generously offer rewards to contributors and motivations to punitively impose costs on free-riders[6]. While prior research focused on the former, it is plausible that the polarized and moralized sentiments surrounding COVID-19 vaccination activate the latter, punitive motivations too. Thus, vaccinated people may not only suspend their generosity towards the unvaccinated, but may also express support for the imposition of costs on the unvaccinated by, for example, supporting their exclusion from social relationships or democratic rights and freedoms. Second, in this context, the unvaccinated may react with prejudice towards the vaccinated as well, grounded, for example, in perceived pressure and discrimination[18;19]. Indeed, the first study examining generosity in two-player behavioral economic games after the implementation of COVID-19 vaccines found that the unvaccinated were also less generous towards the vaccinated, although ingroup favoritism was smaller than among the vaccinated[18]. Third, the complexity of the debates surrounding COVID-19 vaccinations may fuel negative stereotypes beyond the dimensions most relevant to cooperative dilemmas. For example, research on impression formation documents that warmth is one major dimension of impression formation, which is directly related to cooperativeness[29]. Consistent with this, research prior to the COVID-19 pandemic finds that vaccinated individuals perceive the unvaccinated as less warm[8]. Research on impression formation, however, also documents that impressions of competence constitutes another and independent evaluative dimension[29]. In the context of COVID-19 vaccines, this other dimension may also be activated as, for example, the vaccinated may perceive the unvaccinated as being unintelligent and incompetent for believing false information regarding vaccinations[30]. Discriminatory attitudes in the context of COVID-19 vaccines may, therefore, come to have a broader cognitive basis.

To empirically examine these possibilities, we leverage large-scale cross-national data. Specifically, we conducted three experimental studies in 21 countries (Study 1; N = 64,440 observations from 10,740 respondents), six countries (Study 2; N = 18,270 observations from 3,045 respondents) and in the United States (Study 3; N = 14,480 observations from 1,448 respondents), respectively, studying the affective, cognitive and attitudinal dimensions of prejudice across groups defined by COVID-19 vaccination status. The data set measures discriminatory attitudes across a diverse set of cultures from all inhabited continents of the world (see Figure 1). As prior research on lack of generosity towards the unvaccinated has been limited to Western democratic contexts[18;8;9], this cross-cultural dataset sheds light on both the ubiquity of discriminatory attitudes against perceived free-riders as well as on the cross-cultural predictors of variation in the strength of such attitudes. If discriminatory attitudes against people not vaccinated against COVID-19 reflects the activation of anti-free-rider sentiments, such attitudes may be more strongly expressed in countries that have invested significantly in the public good of suppressing deaths from COVID-19 and, in particular, in cultures where citizens hold moral expectations that their fellow citizens support the provisions of such goods.

Exclusion from family in 21 countries

Our initial examination focuses on cross-cultural exclusionary attitudes in the context of family relationships and, specifically, the level of antipathy if a close relative was marrying an unvaccinated (versus fully vaccinated) person. Such discriminatory attitudes in family relationships have been a key focus in prior cross-national research on prejudice along racial, ethnic and partisan lines[31;21]. Exclusion from family relationships are cross-culturally relevant,

131 independently of the legal and democratic traditions of the country; discrimination on the basis
132 of membership in politicized groups within families has also been shown to be highly disruptive
133 for the families[32]; and, finally, relative to other forms of discriminatory attitudes (e.g., support
134 for state-sponsored discrimination), discrimination within families is something within the
135 control of individuals and, hence, something that can take immediate effect.

136 We employ conjoint experiments where respondents evaluate fictitious target profiles
137 simultaneously randomized on six attributes including their COVID-19 vaccination status. The
138 conjoint experimental design yields causal traction, provides a cost-effective method for
139 collecting large samples and allows us to examine a wide-range of responses covering affective,
140 cognitive and attitudinal components of prejudice[33].

141 Given our ambition to study discriminatory attitudes rather than generosity, we depart from
142 prior work that relied on incentivized economic games (e.g., the Dictator Game)[18;8;9]. To help
143 assess the validity of the conjoint experimental approach, we performed a number of tests.
144 First, we show that people perceive measures focusing on social interactions as more
145 ecologically valid than those focusing on monetary transactions captured by economic games
146 (paired sample t-test: $\Delta M = 0.15$, 95% CI = [0.14, 0.16], $t(1447)=24.6$, $p < 0.001$, see Extended
147 Data Figure 1 and Supplementary Information [SI] Section K for details), making the present
148 findings less vulnerable to criticisms regarding ecological validity. Second, to assuage potential
149 concerns about social desirability bias from self-reported measures, we report experimental
150 evidence indicating that people readily and openly admit their antipathy towards vaccination
151 outgroups, even using a traditional, direct survey question (m = 44%, 95%CI = [0.40,0.48]).
152 Indeed, this estimate of antipathy is not statistically different from the estimate we get using
153 the forced response technique, specifically designed to alleviate social desirability (m = 39%,
154 95%CI = [0.35,0.43], $\chi^2(1,1210) = 2.31$, $p = 0.13$, see Extended Data Figure 2 and SI Section

L). Finally, despite the presumed advantages of incentivized behavioral measures, we demonstrate that ingroup bias in generosity across vaccination groups is identical whether estimated with incentivized measures replicating prior research (M = 29; 95%CI [26, 32], one-sample t(724) = 19.4, $p < 0.001$) or with non-incentivized, self-reported measures (M = 30; 95%CI [28, 33], one-sample t(722) = 21.0, $p < 0.001$; ΔM = -1.45, 95%CI [-5.5, 2.6], statistically equivalent to 0, TOST two-samples t-test, t(1445) = 2.16, $p < 0.05$, see details in SI section M).

In the conjoint experiment for Study 1, we adapted a widely used instrument of exclusionary reactions in family relations[31] and examine a specific set of discriminatory attitudes: How unhappy respondents would be if a close relative was marrying an unvaccinated versus vaccinated person. Furthermore, we assess the potential cognitive bases for discriminatory attitudes. First, we measure a reasonable basis for antipathy towards vaccination outgroups, namely fear of infection[34]. (We do note that during the collection of these studies, the vaccine-evading Omicron variant was dominant[35], and vaccine-induced immunity against infection spread was waning[36] in most societies. This increased the chances of being infected by vaccinated people and thus decreased the risk of interacting with unvaccinated individuals relative to vaccinated individuals.) While fear of infection is likely more pronounced among the vaccinated, some unvaccinated individuals have been found to hold the misinformed belief that vaccinated people themselves spread COVID-19 through vaccine shedding[37]. Second, we assess the two key negative trait impressions underlying prejudice according to research on impression formation and prejudice: perceptions of untrustworthiness and unintelligence[29].

With the help of YouGov and Ipsos survey agencies, we collected high quality, quota-sampled, original survey data from 21 countries that had widespread access to vaccines against COVID-19 (Study 1: 64,440 observations from 10,740 respondents). The data were collected

179 in a diverse set of cultures from all inhabited continents of the world. As detailed in the Methods
180 section "Study 1 - Data and generalizability", the samples can be considered representative of
181 the countries' online populations (except for India). This large, cross-cultural dataset not only
182 allows us to quantify discriminatory attitudes in a wide range of countries but also to investigate
183 sources of cross-cultural variation in its levels. Note that our pre-registered analyses in Study
184 1 focus on antipathy towards outgroups, pooling across respondent vaccination status. Given
185 that we find large asymmetries by vaccination status, we report below estimates separately for
186 vaccinated and unvaccinated respondents. However, pooled estimates – reported in
187 Supplementary Information (SI) Section F – mirror these results very closely given the
188 relatively small share of unvaccinated respondents.

189 Our results reveal that vaccinated respondents (N = 54,054) exhibit exclusionary attitudes
190 towards unvaccinated individuals (see Figure 2, left panel). On average, they are 13 (AMCE
191 95% CI [12, 14], $z = 25.65$, $p < 0.001$) percentage points more unhappy when presented with
192 an unvaccinated (versus fully vaccinated) target. Country-level estimates range from 1 to 36
193 percentage points. We can reject the null (at 5% alpha-level) in 19 of the 21 countries. Malaysia
194 is an outlier with very high exclusionary attitudes (AMCE = 36% points, 95% CI [32, 41], $z =$
195 15.3, $p < 0.001$), while results in Romania (AMCE=1% point, 95% CI [-4, 6], $z = 0.39$, $p =$
196 0.69) and Hungary (AMCE=4% points, 95% CI [-1, 9], $z = 1.74$, $p = 0.08$) are inconclusive
197 (see more discussion in SI Section G). Interaction models estimating conditional AMCEs
198 indicate that while we observe exclusionary attitudes across all demographic groups, they are
199 slightly larger among highly educated (AMCE difference of 5% points), female (by 4% points),
200 more affluent (by 3.5% points), and older (by 2% points) respondents (all *p*s < 0.05, see Section
201 D in the Supplementary Information for details).

Meanwhile, unvaccinated respondents (N = 10,386) exhibit negligible exclusionary attitudes towards vaccinated individuals (see Figure 2, right panel). Their unhappiness is largely independent of the target's vaccination status, with an average marginal component effect of only -2 percentage points (AMCE 95% CI [-4, 0], z = -1.81, p = 0.07; the AMCE difference between vaccinated and unvaccinated respondents is 15% points 95%CI [13, 18], z = 13.33, p < 0.001). Country-level estimates of exclusionary attitudes exhibited by unvaccinated respondents are noisy due to the small sample sizes (90 < N < 1500), ranging between -31 and 10% points. Indeed, unvaccinated individuals in Malaysia, Italy, and Russia even exhibit significant exclusionary reactions towards other unvaccinated individuals (*p*s < 0.01), highlighting how anti-free rider sentiments may take priority over sentiments related to ingroup favoritism[8].

To help assess the substantive size of these effects, it is helpful to compare them to exclusionary attitudes towards a group battling high levels of discrimination in many Western countries: Immigrants from the Middle East[3]. Exclusionary attitudes towards the unvaccinated among vaccinated people (13 percentage points) is two and a half times larger than exclusionary attitudes towards Middle Eastern immigrants (5 percentage points, 95%CI [5, 6], $\chi^2(1, N=54{,}054) = 23.83$, $p < 0.001$). We do not suggest that the characteristics of these groups are comparable but this finding nonetheless suggests that the substantive size of the exclusionary reactions facing the unvaccinated is high. Figures E.1 and E.2 juxtapose country-level estimates of exclusionary attitudes towards the two groups. Unvaccinated targets face significantly more exclusionary reactions than immigrants in 11 out of 21 countries, while immigrants do not face significantly more exclusionary reactions in any of the countries. Notably, exclusionary

attitudes towards immigrants between the vaccinated and unvaccinated are substantively similar and not significantly different from 0 (N = 64,440, AMCE difference 1% point, 95%CI[-1, 3], z = 0.88, p = 0.38) implying that asymmetry in the domain of vaccination cannot be easily explained by omitted variables or design effects (Figure E.3). Nor do we find evidence that unvaccinated immigrants from the Middle East face disproportionate exclusionary attitudes compared to unvaccinated natives (N = 64,440, AMCE difference 1% point, 95%CI[0, 1], z = 1.1, p = 0.27, see also Figure E.4).

Stereotypes and exclusionary attitudes

Next, we ask if exclusionary attitudes merely reflect a heightened risk of infection or also activate more fundamental stereotypes. As displayed in Extended Data Figure 3.A, we find large experimental effects of vaccination status among vaccinated respondents on fear of infection (N = 54,054, 38 percentage points, 95% CI: [37, 40], z = 65.99, p < 0.001) and perceptions of untrustworthiness (13 percentage points, 95% CI: [12, 14], z = 27.36 p < 0.001). However, we also find an effect on incompetence (14 percentage points, 95% CI: [13, 15], z = 29.00, p < 0.001), suggesting that stereotypes of the unvaccinated extend beyond the domain of free-riding. As unvaccinated respondents (N = 10,386) exhibit insubstantial exclusionary reactions, it is not surprising that they also do not judge vaccinated respondents as untrustworthy (0 percentage points, 95% CI: [-2, 2], z = 0.2, p = 0.84) or as incompetent (0 percentage points, 95% CI: [-2, 2], z = 0.37, p = 0.71) either. If anything, they fear getting infected with corona by vaccinated people slightly *less* than by unvaccinated people (-2 percentage points, 95% CI: [-5, 0], z = -2.1, p < 0.05). For country level estimates of negative stereotypes against vaccination outgroups, see SI Section C.

Our study also replicates a well-known finding from the impression formation literature: Impressions of trustworthiness have the largest impact on overall exclusionary attitudes[29]. Judging from a linear regression with respondent fixed-effects, exclusionary attitudes are more closely associated with impressions of (un)trustworthiness (β = 0.24, 95%CI [0.23,0.25]) than with impressions of (in)competence (β = 0.17, 95%CI [0.16,0.18], Wald-test for equal effects: $\chi^2(1, N=64{,}440) = 62.6$, $p < 0.001$), or even infection concerns (β = 0.16, 95%CI [0.15,0.17], Waldtest for equal effects: $\chi^2(1, N=64{,}440) = 112$, $p < 0.001$, see also Extended Data Figure 3.B). While concerns about infection risks do shape exclusionary attitudes towards the unvaccinated, these findings suggest that negative stereotypes further enhance these attitudes.

Culture and exclusionary attitudes

The results provide strong evidence that exclusionary attitudes against perceived free-riders in the domain of vaccinations emerge reliably across cultures, reflecting the deep-seated nature of the psychology of cooperation[6]. At the same time, it is clear that the strength of the observed exclusionary attitudes exhibits substantial cross-cultural variation (see SI Section O.1 for formal evidence). Figure 3 displays exclusionary attitudes towards the unvaccinated by vaccinated respondents against three pre-registered macro-indicators–COVID-19 deaths, vaccinations (both standardized to population size), and social trust–as well as an exploratory indicator, cultural tightness. Whereas COVID-19 deaths and vaccination rates indicate society-wide investments in the public good of suppressing the epidemic, social trust (i.e., the tendency to trust fellow citizens) and cultural tightness (i.e., the strength of social norms and the degree of sanctioning within societies,[38]) are indicators of the moral expectations of fellow citizens and the willingness to sanction violations of these expectations. Countries that managed to keep

the death toll of the coronavirus low show very strong exclusionary attitudes towards the unvaccinated at around 20 percentage points on average. In contrast, countries that struggled to mitigate the epidemic show much lower exclusionary attitudes. Spearman's rank order correlation between death and prejudice is $\rho(21) = -0.62$, 95%CI [-0.83, -0.26]. At the same time, the association of exclusionary attitudes with actual vaccination levels is inconclusive $\rho(21) = 0.38$, 95%CI [-0.06, 0.70]. Although there is a tendency for highly vaccinated nations to display more exclusionary attitudes, and countries with lower compliance to display less, there is also considerable deviations from this trend, with outliers like Argentina (high vaccination, little prejudice) and South Africa (high prejudice, low vaccination). In the SI Section G, we furthermore analyse policy stringency that is a direct measure of how much national governments invested in suppressing infections. We find no reliable association between stringency and prejudice towards the unvaccinated ($\rho(21) = 0.23$ 95%CI [-0.22, 0.6], see Extended Data Figure 4).

Prior research has demonstrated that epidemic suppression hinges on citizens' normative and moral expectations such that countries with higher social trust[39] and a tighter culture[40] suppressed the epidemic toll more effectively. As observed in Figure 3, these cultural differences are also associated with higher prejudice towards the unvaccinated. Specifically, exclusionary attitudes are higher in countries with higher social trust (Spearman's $\rho(21) = 0.57$, 95%CI [0.19, 0.81]). In countries where large majorities believe that "most people can be trusted", the exclusionary reaction towards the unvaccinated is larger. Meanwhile, in countries where most believe that "you need to be very careful in dealing with people", exclusionary attitudes are lower. Similarly, exclusionary attitudes are higher in countries with a tighter culture, oriented towards strong norms and the sanctioning of norm violations ($\rho(16) = 0.62$, 95%CI [0.18, 0.85]). These latter associations suggest that cultures that place stronger moral

297 expectations on individuals not only more effectively produce the public good of epidemic
298 control[39;40] but also constitute a fertile ground for exclusionary attitudes against the
299 unvaccinated, as they may be perceived to free-ride on the collective effort[8]. In SI Section O.2,
300 we provide robustness checks for these cross-cultural conclusions, addressing potential threats
301 to the generalizability of data obtained via online surveys.
302
303 **Antipathy across six countries**
304 In Study 2, we focus on the affective component of prejudice. Specifically, we conducted a
305 pre-registered, conceptual replication of Study 1 and, in the context of a conjoint experiment,
306 asked participants to rate fictitious individuals that vary in terms of vaccination status (as well
307 as other attributes) on a seven-point like-dislike scale.
308 Study 1 also showed that exclusionary attitudes are intertwined with a fear of infection.
309 While fear of infection is a weaker correlate of exclusionary attitudes than trustworthiness
310 impressions, the finding nonetheless raises the possibility that prejudice against the
311 unvaccinated may be restricted to relationships characterized by physical interaction. The focus
312 on pure antipathy in a neutral evaluation task allows us to examine this possibility.
313 Furthermore, to gain perspective on the size of antipathy across vaccination groups, Study 2
314 also changed the benchmark group from Middle Eastern migrants to a more diverse set of four
315 groups, which are also frequent targets of prejudice: Drug addicts, ex-convicts, people with
316 mental illnesses, and atheists[41;4;5]. These groups were chosen to offer some variance on how
317 much perceived control people have in determining their group membership and how much of
318 a threat they pose on members of society.
319 With the help of YouGov survey agency, Study 2 was fielded in six countries (Germany,
320 India, Indonesia, Morocco, South Africa, United Kingdom) representing both Western affluent

and non-Western developing nations. We recruited about 500 respondents per country, quota sampled on age, gender and region, as well as education in Germany and the UK (see details in SI Section A). As before, each participant rated three pairs of target profiles (Study 2: 3,045 respondents, 18,270 observations). All analyses, unless otherwise noted, were preregistered (see Data Availability Section for details).

Our data shows that the vaccinated feel antipathy towards the unvaccinated, even in a neutral evaluation task without any indication that participants would physically meet the fictitious targets (see Figure 4). Across all six countries, we find that vaccinated respondents (N = 15,966) dislike unvaccinated targets more than vaccinated targets, on average by 14 percentage points (AMCE 95% CI [13, 15], $z = 25.94$, $p < 0.001$). Conversely, unvaccinated respondents (N = 2,304) on average do not dislike vaccinated targets significantly more than unvaccinated targets (AMCE = 1 percentage points, 95% CI [-1, 4], $z = 1.01$, $p = 0.31$, although Germany is a significant outlier, AMCE = 8% points, 95% CI = [3, 13], $z = 3.12$, $p < 0.001$). We should also note that the substantive size of the prejudice expressed towards the unvaccinated remains high relative to the more diverse set of benchmarks. On average across the six countries, the unvaccinated are disliked as much as people who struggle with drug addiction (15 percentage points, 95%CI [13, 16], Wald-test for equal effects: $\chi^2(1, N=15{,}966) = 0.51$, $p = 0.47$), and significantly more so than people who have been in prison (10 percentage points, 95%CI [9, 11], $\chi^2(1, N=15{,}966) = 18.4$, $p < 0.001$), who are atheists (7 percentage points, 95%CI [6, 8], $\chi^2(1, N=15{,}966) = 67.5$, $p < 0.001$), or who suffer from mental illness (6 percentage points, 95%CI [5, 7], $\chi^2(1, N=15{,}966) = 87.9$, $p < 0.001$). For country level estimates of prejudice towards each of the four benchmarks, see SI Section I.

Study 2 included an additional test. The finding from Study 1 (i.e., widespread existence of exclusionary attitudes in personal relationships) may be less concerning, if members of the groups of vaccinated and unvaccinated are only weakly acquainted across group boundaries and if – consistent with intergroup contact theory – prejudice is high only among individuals with less intergroup contact[42]. Study 2 therefore measured how many relatives and friends respondents have who belong to the vaccination outgroup. Analyses demonstrate that while antipathy is indeed highest among people with no contact with the outgroups (N = 18,270, AMCE = 15% points, 95% CI = [13, 16], $z = 20.36$, $p < 0.001$), it is substantial across all contact levels (AMCEs = 5%–12% points, $zs \geq 2.4$, $ps < 0.05$, see Extended Data Figure 5 and SI Section J).

Restriction of rights in United States

So far, the discriminatory attitudes we have investigated have only been demonstrated in the domain of private relationships. Study 3 therefore examines whether discriminatory attitudes extend into the domain of publicly-recognized rights. As the recognition of such rights differs across cultures, Study 3 was conducted in United States, a country with historical recognition of fundamental rights and freedoms[43]. Study 3 is identical to Study 2, except that the study also included five new outcomes in addition to the measure of antipathy and that answers were obtained on binary scales. Specifically, respondents were asked to evaluate the target's freedom of movement ("This person should be allowed to sit next to me in public transportation"), freedom of residence ("This person should be allowed to move into my neighborhood"), freedom of speech ("This person should be allowed to express their political views on social media freely, without fear of censorship"), access to citizenship ("This person should receive US citizenship, if they are eligible and apply for it"), access to unemployment

benefits ("This person should receive unemployment benefits, if they are eligible and apply for it"). We collected data via YouGov from 1,448 US Americans quota sampled on age, gender, region, education and race. Each respondent evaluated five pairs of targets yielding a final sample size of 14,480 observations. All analyses, unless otherwise noted, were preregistered (see Data Availability Section for details). The survey also included the methodological studies discussed in relation to Study 1, and reported in detail in SI Sections K-M.

The results are displayed in Figure 5 and demonstrate that exclusionary attitudes are not restricted to the domain of private relationships. Vaccinated Americans not only feel greater antipathy towards unvaccinated Americans by 16 percentage points (95%CI [14, 19], $z = 13.09$, $p < 0.001$), they are also 28 percentage points less likely to respect their freedom of movement (95%CI [25, 31], $z = 19.4$, $p < 0.001$), 10 percentage points less likely to respect their freedom of residence (95%CI [8, 12], $z = 9.1$, $p < 0.001$), 8 percentage points less likely to support their application for citizenship (95%CI [6, 10], $z = 7.98$, $p < 0.001$), and 7 percentage points less likely both to respect their freedom of speech and to support their applications for welfare benefits (95%CIs [5, 9], $z = 7.23$ and 7.44, respectively, $ps < 0.001$). Vaccinated respondents express significantly higher exclusionary attitudes towards the unvaccinated than against atheists on all six outcomes, than against mentally ill on five outcomes, and than against targets who have been in prison or struggle with drug addiction on three outcomes. Conversely, they do no express significantly higher exclusionary attitudes towards any of the benchmark groups on any of the outcomes than against the unvaccinated (see details on all Wald-tests in SI Section I).

Study 3 results also indicate that unvaccinated Americans also harbor some negative sentiment towards the vaccinated (4 percentage points, 95%CI [1, 7]) but unvaccinated Americans are neither more nor less likely to restrict their rights or freedoms. Finally, additional analyses (see SI Section N) indicate that vaccinated Americans' antipathy towards the unvaccinated is predictive of their support for restricting the rights of the unvaccinated (Spearman's rank order correlations $0.35 < \rho s(1448) < 0.44$).

Discussion

Research on political polarization warns that if socio-political disagreement – even if based on legitimate grievances – permeates interactions between citizens, it can contribute to the entrenchment of conflict[21]. In this study, we have documented that individuals vaccinated against COVID-19 express negative attitudes against unvaccinated individuals in the form of antipathy, stereotypes, support for exclusion from family relationships and support for removal of political rights. In total, these four forms of discriminatory attitudes are consistent with the observation of prejudice according to standard definitions in social psychology. We examined and obtained evidence in support of all four reactions in United States. In the other countries, we only examined some but not all forms of discriminatory attitudes and found evidence in support of the specific negative reactions examined. The only exceptions were Hungary and Romania, where we did not find evidence in support of discriminatory attitudes. Furthermore, we find that discriminatory attitudes towards the unvaccinated is as high or higher than discriminatory attitudes directed towards other common and diverse targets of prejudice including immigrants, drug-addicts and ex-convicts. At the same time, the results demonstrate that prejudice is mostly one-sided. Only in United States and Germany do we find that the

unvaccinated feel some antipathy towards the vaccinated but even here we do not find statistical evidence in favor of negative stereotyping or exclusionary attitudes.

The finding that vaccinated individuals are prejudiced against the unvaccinated but that there is no evidence for the reverse is consistent with work on the psychology of cooperation[6;7] and prior work on vaccinations: The cue that someone refuses to take up a vaccine activates psychological mechanisms designed to deter perceived free-riders among the vaccinated[8;9]. Consistent with the deep-seated nature of anti-free-rider sentiments, the observation of substantial and culturally discriminatory attitudes including support for denial of fundamental rights suggests that negative reactions are easily triggered in the context of perceived public goods. At the same time, the results also reveal that some cultures are especially prone to react with prejudice. Consistent with an anti-free-rider perspective, vaccinated individuals in cultures with stronger cooperative norms react more negatively against the unvaccinated. Such norms are more reliably associated with cross-cultural differences in discriminatory attitudes than are actual country-level differences in government efforts to produce epidemic control. What seems to trigger discriminatory attitudes towards the unvaccinated is less governments' efforts to reduce deaths from COVID-19 and more how such efforts resonate with larger cultural norms and perceived obligations.

In this regard, it is relevant to note that the decision to refuse vaccination against COVID-19 may reflect many factors beyond a moral failure to appreciate collective goals. A recent review of almost one hundred empirical studies identified eighteen robust correlates of COVID-19 vaccine hesitancy in high-income countries[44]. Even if negative stereotypes are statistically true, they are unlikely to adequately capture the full motivations of every individual. For example, an unvaccinated person may have medical conditions[45], immunity from prior infection[46], a history of mental health issues that may intensify fear of vaccinations[47],

negative past experiences with health authorities (especially as a minority)[48], concerns due to country-specific public health scandals[49], or ethical considerations about vaccine equity[50].

While moralistic communication of collective responsibilities may be an effective strategy to increase vaccination uptake[8], such strategies may have unintended negative consequences in the form of eliciting prejudice[51], especially in cultures with strong cooperative norms. Research on prejudice towards minority groups warns that experiences of prejudice and discrimination may have negative long-term effects, hurting well-being[52], eroding identification with majority society[53], and breeding mistrust of the state, including health authorities[54]. If the consequences of prejudice towards the unvaccinated resemble the consequences of prejudice against minority groups, they may exacerbate the mistrust and alienation that led to vaccine refusal in the first place[13;20].

In the short run, prejudice towards the unvaccinated may complicate pandemic management. In the long run, it may mean that societies leave the pandemic more divided than they entered it. Finally, our findings also offer a lesson for global challenges beyond the current pandemic. Large social crises – for example, the climate crisis – are often characterized by collective action dilemmas due to the need for substantial behavior change among the general public[55]. To effectively manage such crises, the authorities should seek to avoid fueling deep animosity between citizens. Indeed, as moral condemnation is often easily and spontaneously activated among the general public during a crisis[11], the authorities and politicians should consider tempering social animosities as an important part of their mandate, especially when societal conflict becomes more entrenched.

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Methods

Study 1

Data and generalizability

We collected data between December 3, 2021 and January 28, 2022 from 21 countries: Argentina, Australia, Austria, Brazil, China, Denmark, France, Germany, Hungary, India, Indonesia, Italy, Malaysia, Mexico, Morocco, Romania, Russia, South Africa, Spain, the United Kingdom, and the United States. Data was collected through online panels by Ipsos in China, and by YouGov in all other countries. All participants provided informed consent and were reimbursed according to their standing agreements with the data provider. All studies (Studies 1-3) were exempt from formal ethical review by Danish law. As per section 14(2) of the Act on Research Ethics Review of Health Research Projects, "notification of questionnaire surveys ... to the system of research ethics committee system is only required if the project involves human biological material." The studies fully comply with Aarhus University's Code of Conduct and with the ethical standards set by the Danish Code of Conduct for Research Integrity.

We sought to recruit 500 adult respondents from each country, quota sampling on age, gender, and region of residence, and – conditional on feasibility – also education (in Australia,

Brazil, Denmark, France, Germany, Italy, Mexico, Russia, Spain, UK, and US) and race (in the US). See Extended Data Table 1 for demographic details. Quotas are always set to mimic the national population, except in Indonesia, Morocco, and Malaysia, where due to feasibility issues, they are set to the demographic characteristics of the online population and, in India, where they are set to the demographic characteristics of the national urban population. Respondents who failed a simple bot test were screened out at the beginning of the survey. For additional demographic information, as well as more details on the quotas set, see Section A in the OA. Questionnaires were translated to the official language of the country by professional translators employed by a translation agency (see deviations from this rule in SI Section B). Each translation was independently quality checked by another translator at the agency, and a native speaker recruited by the researchers.

Our samples cover a diverse set of cultures from all inhabited continents of the world. That said, our sample intentionally excludes the poorest countries where COVID-19 vaccines were not yet widely available to the public and where, accordingly, we would not expect vaccination status to lead to prejudice. Furthermore, despite the quotas set, our samples are not fully nationally representative as they exclude parts of society who have no internet access, or face other systemic disadvantages (e.g., are illiterate or do not speak the official language of the country). Prior research thus concludes that for results from cross-national data collected via YouGov's online panels in low- and middle-income countries "it is better to think of [them] as representative of the online population."[56]. At the same time, during a pandemic, online surveys constitute a safe and efficient data collection method that allows voices from diverse cultures to be heard. Consistent with this, the World Health Organization refers to the use of online surveys as "the standard approach" for behavioral insights during the pandemic[57]. Our main

665 survey vendor, YouGov, aided Imperial College London to capture global behavioral dynamics
666 during the pandemic[58].

667 Prior research suggests that cross-cultural differences can be reliably studied using online
668 surveys[59;60;61] and that studies using experimental designs (as we do) are particularly robust
669 across a variety of sampling methods[62;63]. Nonetheless, it is important to acknowledge and
670 address limitations to generalizability of online surveys. The key threat in this regard is whether
671 differences between online and national populations may endanger the robustness of the
672 crosscultural conclusions. To examine the consequences of this threat to inference, we report
673 multiple robustness checks of the data and analyses. First, SI Section A compares the most
674 relevant objective benchmark, actual vaccinations against COVID-19 in the adult national
675 population, against those observed in the surveys, finding high correspondence. Second, SI
676 Section D directly examines treatment heterogeneity in two of the key indicators associated
677 with internet access, education and income, and finds very little treatment heterogeneity, even
678 in low- and middle-income countries (see Extended Data Figure 6. Third, SI Section O.2
679 directly quantifies the potential threat to inference and examines the robustness of the cross-
680 cultural conclusions to potential differences in prejudice between online and offline
681 populations. It finds that the cross-cultural conclusions are robust to even the extreme
682 assumption that offline population hold *zero* prejudice against the unvaccinated (see Extended
683 Data Figure 7). Fourth, SI Section O.2 also reports a stress test, which examines the
684 consequences of simultaneous violations of our two conjectures that (a) our samples represent
685 the online populations and (b) that the represented and non-represented populations show
686 similar prejudice. This test finds that the conclusion of cross-culturally pervasive prejudice
687 would hold even if both of our conjectures were wrong. Overall, both prior work and extensive
688 robustness analyses strongly suggest that our conclusions hold as stated.

Experimental design

Our design is a subtle, conjoint experimental implementation of Bogardus'[31] classic social distance scale. We presented participants with brief descriptions of a series of fictitious individuals and asked them to imagine that these are people whom one of their close relatives intends to marry. One of the six attributes describing these target individuals has been their COVID-19 vaccination status, randomly varying between "fully vaccinated" and "unvaccinated." Importantly, this is a minimalist manipulation of vaccination status, simply labeling target individuals with their group membership and thus offering no reason or justification for their choice.

We were interested whether participants would have higher exclusionary attitudes against unvaccinated individuals marrying into their families. To benchmark the size of this hypothesised prejudice, another attribute has been labeled "family background" and distinguished between people "born and raised in [the respondent's country]" and people who "immigrated from the Middle East." Middle Eastern immigrants serve as an excellent benchmark as widespread prejudice against them has been widely documented[3].[1] The other four attributes (age, occupation, hobbies, and personality) were included to increase ecological validity and to reduce experimenter demand and social desirability. All in all, we collected data from 10,740 individuals.

Extended Data Table 2 displays the six attributes and their levels. Each target profile was sampled completely at random from the $2 \times 2 \times 6 \times 6 \times 6 \times 5 = 4{,}320$ unique combinations of

[1] That said, this does not mean that all countries in our sample must be prejudiced against Middle Eastern immigrants. While it has been important for us that none of our samples come from the Middle East (as it would render the attribute meaningless), factors like a shared religious identity may temper prejudice against Middle Easterners. To minimize this latter effect, we deliberately avoided using the term "Muslim".

attribute levels. Following best practices in the literature[33], we presented two targets at a time, side by side. Each respondent rated six random targets independently across three trials, yielding a total sample size of 64,440 observations. We also randomized between respondents the order in which the attributes appeared.

Measures

Respondents rated each target profile independently by indicating their agreement or disagreement with a series of four statements on a simple yes/no scale. Specifically, we measured respondents' *exclusionary attitudes* with the statement, "I would be unhappy if this person married one of my close relatives"; *fear of infection* with the statement, "I would be afraid that this person infected me or my family with COVID-19"; perceptions of *intelligence* with "I think this person is unintelligent"; and *trustworthiness* with "I think this person is untrustworthy."

We also collected background information on all respondents. Most importantly, prior to the treatment, we asked whether respondents themselves were vaccinated or not. We label all respondents who received at least one vaccine as "vaccinated," and all other respondents, including those who refused to answer the question, as "unvaccinated." We also rely on demographic data shared by the survey provider, which we dichotomized into male and female respondents, older and younger respondents (by splitting at the sample median in each country), respondents with and without a completed higher (tertiary) education, and finally, poor respondents with a gross household income below 70% of the national median and not poor respondents.

Finally, our analyses rely on a series of country-level predictors. We measure pandemic severity with the cumulative number of confirmed COVID-19 *deaths* per 100K people in the

734 total population on the first day of data collection in the country as measured by Johns Hopkins
735 University. We measure the *vaccination rate* of the country with the total number of people
736 who received at least one vaccine dose per 100 people in the total population on the first day
737 of data collection in the country as measured by Our World in Data. We measure *social trust*
738 with the proportion of respondents who said "most people can be trusted" (versus "you need to
739 be very careful in dealing with people") in the latest World Values Survey data available for
740 the country. Finally, we use cultural tightness-looseness scores from[38] as a (post-hoc) predictor
741 of prejudice against the unvaccinated. Note that tightness scores are available for 16 out of our
742 21 countries, thus Denmark, France, Morocco, Romania and South Africa are omitted from
743 these analyses.
744
745 *Modeling*
746 Following standard practices in the literature on conjoint experiments[64], we analyze our
747 data with OLS regression models regressing one-by-one the four outcomes on the six
748 categorical attributes. The models include post-stratification weights. We cluster standard
749 errors on respondents. Our four hypotheses are evaluated on the average marginal component
750 effect (AMCE) of vaccination attribute (scaled to indicate outgroups) on the four outcomes.
751 AMCEs can be interpreted as the percentage point change in the proportion of respondents
752 reporting exclusionary attitudes, perceived untrustworthiness, unintelligence, or fear of
753 infection, *caused* by changing a target's vaccination status from ingroup to outgroup. All
754 significance tests reported in the manuscript – unless otherwise noted – are two-sided.
755 To estimate country-level effects, we rerun these models in each of the 21 countries
756 separately. To estimate heterogeneities in prejudice between vaccinated and unvaccinated
757 respondents, as well as between demographic groups, we rerun models on split samples. To

estimate country-level relationships between exclusionary attitudes and macro-level indicators, we rely on descriptive plots and Spearman's rank order correlations.

Our identification strategy rests on the random assignment of vaccination status to target individuals[64]. We report the standard diagnostic tests for conjoint experiments in SI Section O.6. We find little reason for concern, although we acknowledge that participants speeding through the experiment dilute the observed experimental effects (see Figure O.21) and that there are some carry-over effects for exclusionary attitudes but not the other three outcomes (see Figure O.24). We also note that insofar as some of our respondents falsely claim to be vaccinated, our estimates of prejudice towards the unvaccinated are likely to be too conservative.

Finally, in SI Section O, we report robustness tests. All our conclusions replicate when our regressions are implemented in a Bayesian multilevel framework, when we drop post-stratification weights, and when we exclude respondents claiming no prior opportunity to get vaccinated.

Study 2

Study 2 sought to conceptually replicate and extend the results of Study 1. First, it relies on an alternative, purely affective measure of prejudice, which cannot be confounded by concerns of infection risk. Second, it uses an alternative set of benchmark groups to get additional perspective on the substantive size of the prejudice faced by the unvaccinated. Third, it tests whether antipathy against vaccination outgroups is lower among people who have more contact with members of the outgroup. Finally, it conceptually replicates our findings in a period after the omicron wave has receded and when concerns about the pandemic were less outspoken.

Data and design

Our data was collected in May, 2022 from six countries: Germany, India, Indonesia, Morocco, South Africa, and the UK. As before, our data provider, YouGov, quota sampled minimum 500 respondents per country from online panels. All participants provided informed consent and were reimbursed according to their standing agreements with the data provider. The study was exempt from formal ethical review (see above under Study 1).

The design of Study 2 closely mirrors the conjoint experimental design described above for Study 1. For the sake of brevity, we therefore focus on deviations here. First, we omitted the framing of the relationship between respondent and target as a prospective close family member. Instead, we simply presented target individuals to respondents, whom they were asked to evaluate on a standard like-dislike scale. Second, we replaced the family background attribute with a new one called personal information. Under this inconspicuous label, we included references to membership in one of four groups, which are well documented for facing (various levels of) prejudice: drug addicts, the mentally ill, convicts and atheists. As a neutral comparison, the attribute also had a control condition – "no additional information". These four groups intentionally vary in the extent membership is conditional on personal choice versus luck, and whether they pose a danger on others. For the detailed description of all attributes (including two minor changes on background attributes), see SI Section B. Finally, beyond personal vaccination status, we also measure the personal experience of contact with vaccination outgroups and model the antipathy towards outgroups conditional on this variable.

As before, the target profiles are sampled completely at random from the $2 \times 5 \times 6 \times 5 \times 6 \times 5 = 9{,}000$ unique combinations of attribute levels (see details in Extended Data Table 3. Each respondent evaluated three pairs of targets. This yields a final sample size is 18,270

observations from 3,045 individuals. All hypotheses, materials and analyses were pre-registered at osf.io/a7hsu.

Measures

To measure contact with vaccination outgroup members we asked, pre-treatment, how many relatives and friends do [respondents] have who are [not] vaccinated against COVID-19? The response options were: None at all, 1-2, 3-5, 6-10, More than 10. The question always referred to the outgroup, based on a measure and categorization of personal vaccination status identical to the one used in Study 1.

General impressions of the targets were measured on a standard seven-point Likert scale from strongly dislike to strongly like. Respondents were prompted for each target to indicate, how much do [they] like or dislike person [A-F].

Modeling

We followed the same modeling strategy as in Study 1. We recoded the continuous dependent variables to the 0-1 range, with higher values indicating more dislike. To investigate if respondents with more contact with outgroups express lower antipathy towards them, we preregistered an interaction model, estimating antipathy conditional on contact levels, treated as a categorical variable with no contact as the reference category.

Study 3

The primary ambition of Study 3 was 1) to extend previous results relying on a wider range of outcome measures tapping into various forms of prejudice. Besides, it also included two additional experiments, relying on alternative paradigms for measuring prejudice and

829 generosity across groups. Accordingly, 2) we tested whether people are less generous with
830 unvaccinated others in an economic game both with and without monetary incentives[8;9;18]. 3)
831 We also measure prejudice using Bogardus' family context, both with a standard direct
832 question and employing a forced response technique[65]. Relying on these data, 4) we can
833 investigate if social desirability biases the propensity to admit prejudice towards vaccination
834 outgroups. Finally, 5) we collect data to understand if social interactions as a context for
835 studying negative attitudes across vaccination outgroups are less vulnerable to criticism
836 regarding ecological validity than standard economic games. All hypotheses, materials and
837 analyses were pre-registered at osf.io/ypc6a.
838
839 *Data and design*
840 We collected data from 1,448 adults living in the USA in May, 2022 (simultaneously with
841 Study 2). As before, respondents were recruited from YouGov's online panel using quota
842 sampling on gender, age, region, education, and race. All participants provided informed
843 consent and were reimbursed according to their standing agreements with the data provider.
844 The study was exempt from formal ethical review (see above under Study 1).
845 The conjoint experimental design was identical to that of Study 2, except each participants
846 rated five pairs of target profiles. This yielded a final sample size of 14,480 observations in the
847 conjoint experiment. The study also included two additional experiments. First, replicating
848 Henkel et al.[18], respondents participated in a Dictator Game, where an allocator can give some
849 of their 100 points endowment to another player, the recipient. All participants played in the
850 role of the allocator, and were randomly matched with another respondent in the survey (post
851 hoc), about whom they only knew whether they are vaccinated or unvaccinated against
852 COVID19. We used the strategy method and elicited an allocation for both types of partners

(in a random order). We experimentally manipulated between subjects, whether participants played for a monetary incentive. Specifically, we informed a random half of the participants that the points they divide in the game are worth money at a rate of 100 points = 250 YouGov points. We calibrated this to correspond to roughly $0.20, an incentive equal[8;9] or higher[18] than those used in prior research.

Second, we also measured whether respondents agreed or disagreed with the statement "I would be unhappy if a person [not] vaccinated against COVID-19 married one of my close relatives." The statement always referred to vaccination outgroups. Importantly, we manipulated between participants whether the question was asked directly, or embedded in a forced response design, which uses a randomization device to mask the responses of individual respondents, while retaining the ability to estimate the sample level agreement. Specifically, using a thirdparty random number generator, respondents "drew" an integer between 1 and 6. If they got 1 or 6, they were "forced" to respond "agree" or "disagree", respectively. If they got anything in between, they answered freely, according to their true preference. This method is designed to remove social desirability bias from sensitive survey questions[65].

Measures

In the conjoint experiment, participants evaluated six statements for each target, indicating if they 1) like; if they support their applications for 2) citizenship and 3) unemployment benefits; and if they respect their 4) freedom of expression, 5) freedom of residence, and 6) freedom of movement.

Following a brief explanation of the rules of the dictator game (dubbed an "allocation task"), participants were asked, "How many points would [they] give to this vaccinated/unvaccinated

person?”. We calculate the difference in points allocated to vaccination outgroups versus ingroups. Higher scores indicate more ingroup favoritism.

In the third experiment, we calculated the proportion of participants who indicated that they would be unhappy if someone from the vaccination outgroup would marry into their family. This is a simple proportion of “yes” answers to the direct question, but in the forced response condition we must correct the counts to account for the fact that a third of all respondents are forced to respond one way or another. Accordingly, we subtract 1/6 of the total sample size both from the agree and the disagree responses. We test whether the proportion of prejudiced respondents is statistically significant from 0 and whether prejudice is higher or lower in the forced response condition, compared to the direct question condition.

For the measure on the best context to study discriminatory attitudes against vaccination outgroups, we operationalize ecological validity as the frequency with which people encounter situations similar to the one described in the study. Specifically, participants answer how often or rarely they encounter six situations, three of which describe social interactions (e.g. “I get upset when I think about interacting with all the people [not] vaccinated against COVID-19.”) and three describing monetary transactions (e.g. “I consider donating money to individuals [not] vaccinated against COVID-19.”).

Modeling

For the conjoint experiment, we follow the very same analysis strategy as described for Study 1. For the Dictator Game, we conduct simple t-tests to estimate if participants show significantly more generous towards their in-group members, and if the size of this in-group favoritism is affected by the incentives offered. For Bogardus’ measure of social distance, we

estimate uncertainty of the estimates both with standard confidence intervals, but also perform a chi-squared test, to see if social desirability biases estimates compared to the direct question. Finally, the measures of ecological validity, again are compared with t-tests.

Data availability

All pre-registrations, data, materials, and computer code necessary to reproduce or replicate our analyses are available at https://osf.io/7hszd.

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Author contributions

A.B., F.J. & M.B.P. designed the experiments; A.B. & M.B.P. conducted the experiments; A.B. analyzed data with inputs from F.J. & M.B.P.; A.B. and M.B.P. wrote the paper; All authors approved the final manuscript.

Competing interests

The authors declare no competing interests.

Additional information

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Figure 1: World map highlighting the countries included in Study 1. Countries are colored by the share of vaccinated citizens in the population on the first day of data collection (2021 December–2022 January).

Figure 2: The average level of exclusionary attitudes in family relationships towards vaccination outgroups (i.e., towards the unvaccinated for vaccinated respondents and towards the vaccinated for unvaccinated respondents. Total N = 64,440.). Exclusionary attitudes reflect being unhappy if a close relative married a person from the vaccination outgroup versus ingroup, with more positive coefficients indicating more exclusionary attitudes towards the outgroup relative to the ingroup. Purple and orange points denote country-level average marginal component effect estimates (Ns > 3,000) for vaccinated and unvaccinated respondents, respectively. Black points denote the pooled sample and include an estimate for exclusionary attitudes towards immigrants from the Middle East too. Error bars denote 90 and 95% confidence intervals. For more details, see Study 1 - Modeling under the Methods section.

Figure 3: The relationship between country-level indicators and cross-national levels of exclusionary attitudes among the vaccinated towards the unvaccinated. The country-level indicators are country-level deaths from COVID-19; the national proportion of people expressing trust towards fellow citizens; the national proportion vaccinated against COVID-19; and cultural thightness scores. Labeled dots denote countries, straight black lines denotes best fitting regression lines, and gray curves denote loess curves. Spearman's rankorder correlations across the four facets: deaths $\rho(21) = -0.62$, 95%CI [-0.83, -0.26]; social trust $\rho(21) = 0.57$, 95%CI [0.19, 0.81]; vaccination $\rho(21) = 0.38$, 95%CI [-0.06, 0.70]; tightness $\rho(16) = 0.62$, 95%CI [0.18, 0.85]. Total N = 64,440.

Figure 4: The average level of antipathy towards vaccination outgroups (i.e., towards the unvaccinated for vaccinated respondents and towards the vaccinated for unvaccinated respondents. Total N = 18,270). Antipathy reflects disliking a person from the vaccination outgroup versus the ingroup, with more positive coefficients indicating higher relative antipathy for the outgroup. Purple and orange points denote country-level average marginal component effect estimates (Ns > 3000) for vaccinated and unvaccinated respondents, respectively. Black points denote the pooled sample and include estimates for antipathy towards various other common targets of prejudice. Error bars denote 90 and 95% confidence intervals. For more details, see Study 2 - Modeling under the Methods section.

Figure 5: Affective and attitudinal prejudice against vaccination outgroups in the USA (i.e., towards the unvaccinated for vaccinated respondents and towards the vaccinated for unvaccinated respondents. N = 14,480). Prejudice reflects relative antipathy towards and support for restricting the rights and freedoms of the outgroup relative to the ingroup. More positive coefficients indicate higher prejudice. Purple and orange points denote average marginal component effects among vaccinated and unvaccinated respondents, respectively. Error bars denote 90 and 95% confidence intervals. For more details, see Study 3 - Modeling under the Methods section.

Extended data

Extended Data Figure 1: Participants think about social interactions substantially more than about monetary transactions with vaccination outgroups. Dots denote means, errorbars denote 95% confidence intervals. N = 1,448. See more details in SI Section K.

Extended Data Figure 2: Proportion indicating unhappiness if a vaccination outgroup member married into their family. The plot contrasts a standard direct question (in red) to a question implemented with the forced response technique (in blue). Both methods indicate identical conclusions. Errorbars denote 95% confidence intervals. N = 1,448. See more details in SI Section L.

Extended Data Figure 3: The role of the three proximate outcomes: fear of infection, untrustworthiness, and incompetence. Panel A displays average marginal component effects of target vaccination status on each of the three outcomes splitting on respondent vaccination status ($N_{vaccinated}$ = 54,054 and $N_{unvaccinated}$ = 10,386). Panel B displays the marginal regression coefficients from regressing prejudice on the three proximate variables simultaneously, while including respondent fixed effects. Errorbars denote 90% and 95% confidence intervals. See more details in SI Section C.

Extended Data Figure 4: Relationship between prejudice against the unvaccinated and policy stringency. Estimates of exclusionary attitudes (based on average marginal component effects). Blue line denotes best fitting linear regression line, and gray lines denotes a loess curve. (Total N = 64,440 observations in 21 countries). Policy stringency is based on the Oxford COVID-19 Government Response Tracker by Hale et al (2020). See more details in SI Section G.

Extended Data Figure 5: Prejudice towards vaccination outgroups conditional on outgroup contact. The left panel shows average marginal component effects and demonstrates that prejudice is highest among respondents with no contact at all, and smallest among those with most contacts. The right panel displays marginal means to offer more nuance. Errorbars denote 95% confidence intervals. Total N = 18,270. See details in SI Section J.

Extended Data Table 1: Study 1 – Sample demographics by country

Notes: **N** refers to the number of observations (not respondents). **Higher ed.** refers to the proportion of respondents who have completed higher education. **Poor** is defined as respondents indicating a gross household income less than 75% of the median. As many respondents refused to reveal their incomes, we included the share of missing data on this variable separately.

Extended Data Figure 6: Heterogeneities in exclusionary attitudes by education and income in each country. Average marginal component effects (AMCEs) for exclusionary attitudes against the unvaccinated by country across lower and higher educated respondents (left panel), and poor and not poor respondents (right panel). Estimates are based on Bayesian multilevel regression models. Error bars denote 90 and 95% credible intervals. Total N = 64,440. See more details in SI Section D.

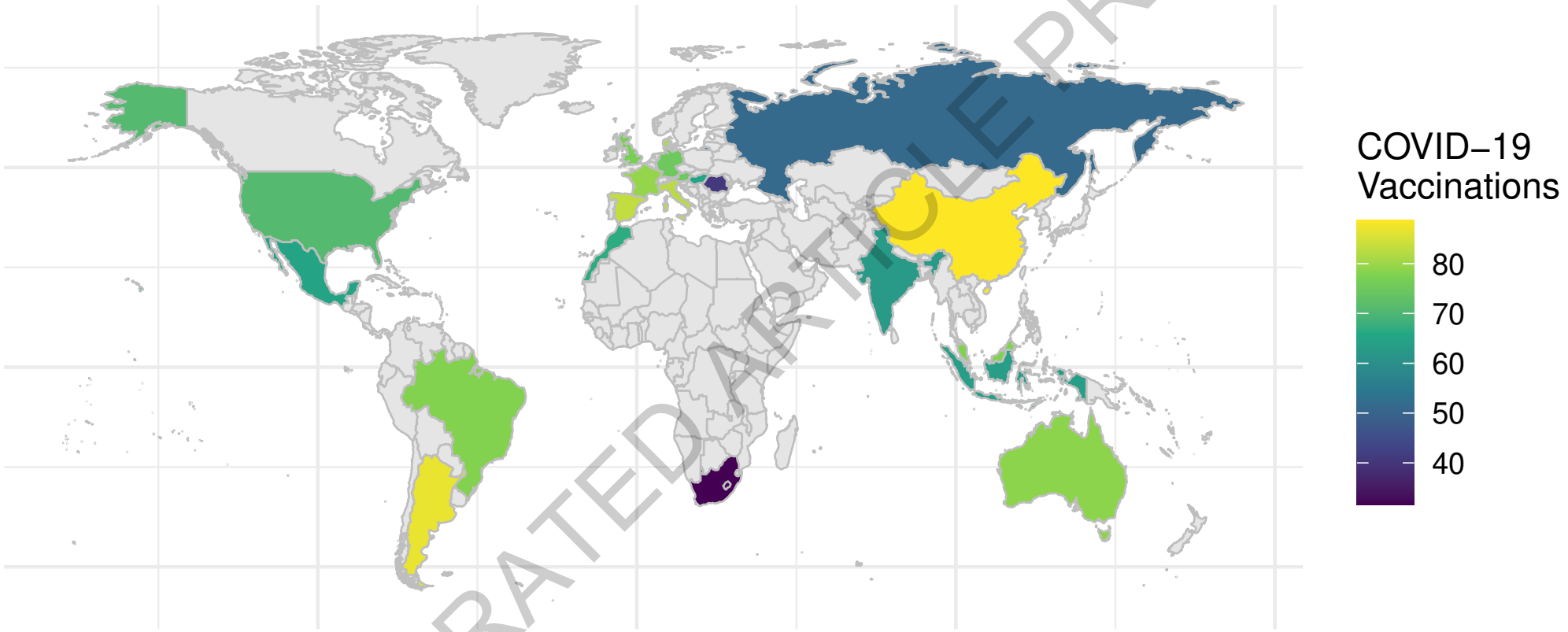
Extended Data Figure 7: Simulations show that even if no offline citizen shows any exclusionary attitudes our main conclusions remain unchanged. Original average marginal component effect estimates of exclusionary attitudes against the unvaccinated (orange dots) and simulations estimating the same under maximal bias from non-online populations (purple dots). Errorbars display 90% and 95% confidence intervals. Total N = 54,054. See more details in SI Section O.2.

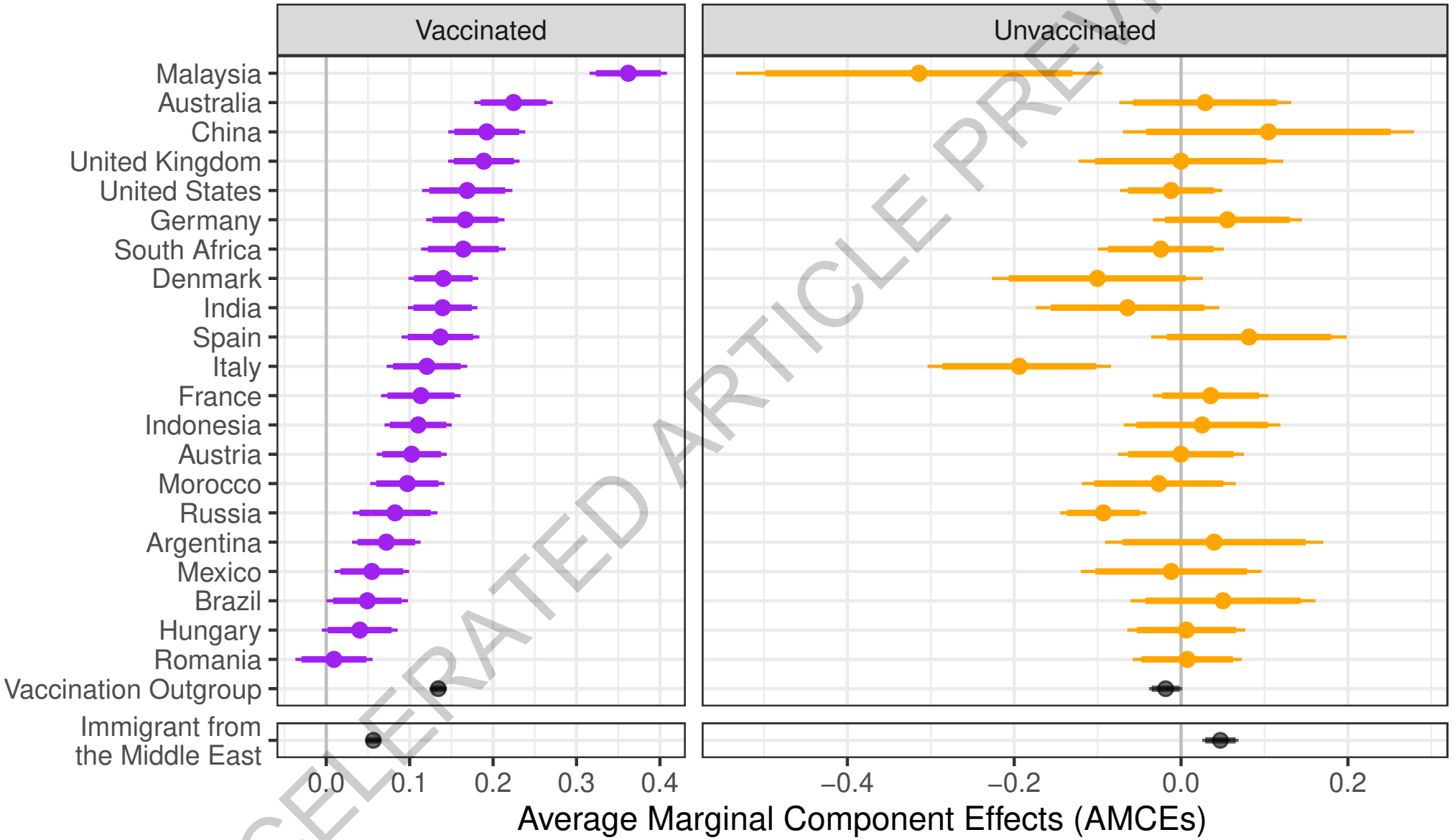
Extended Data Table 2: Study 1 – Attributes and levels in the conjoint experiment

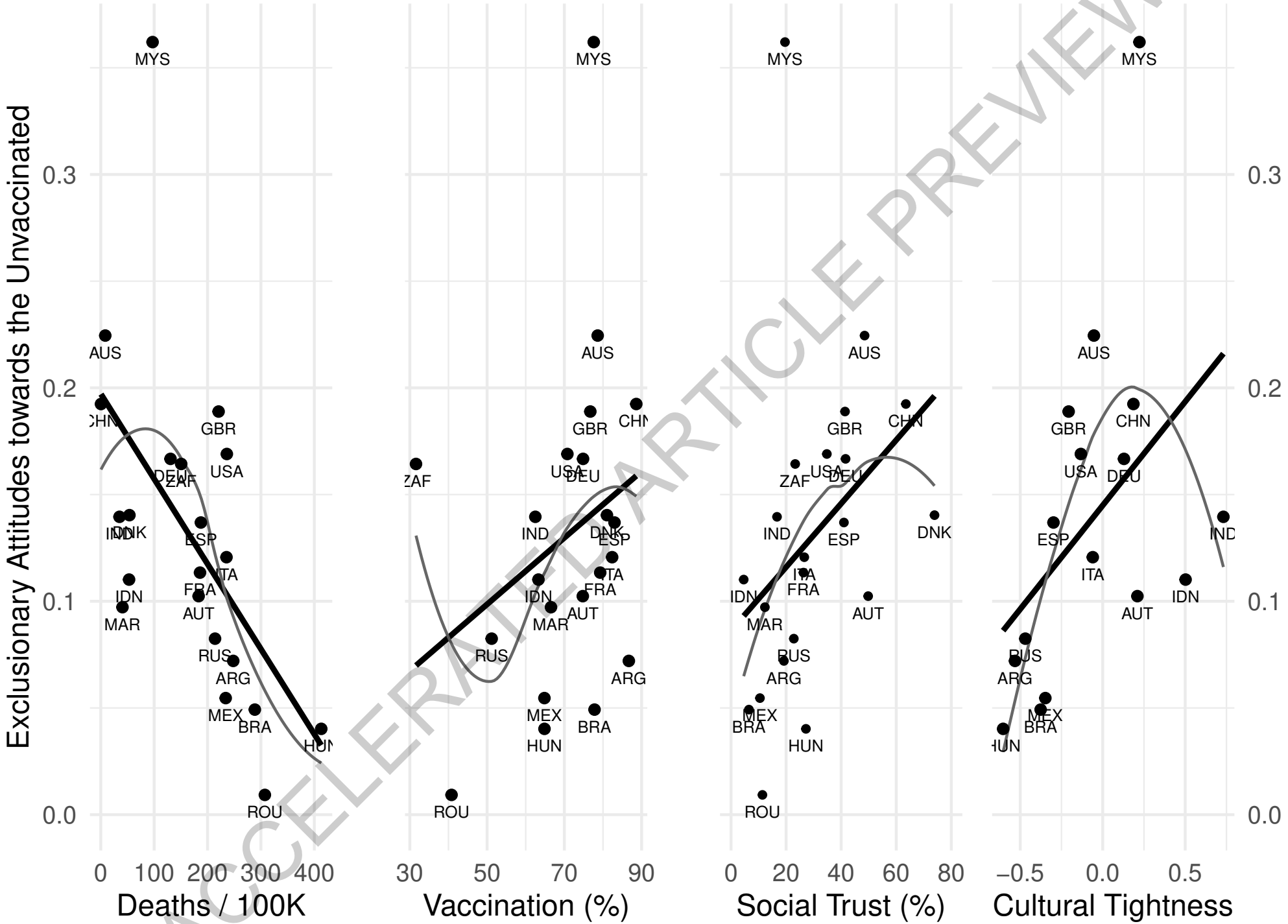
Note: Numbers in parentheses denote the number of levels. {...} was replaced with the country of the respondent.

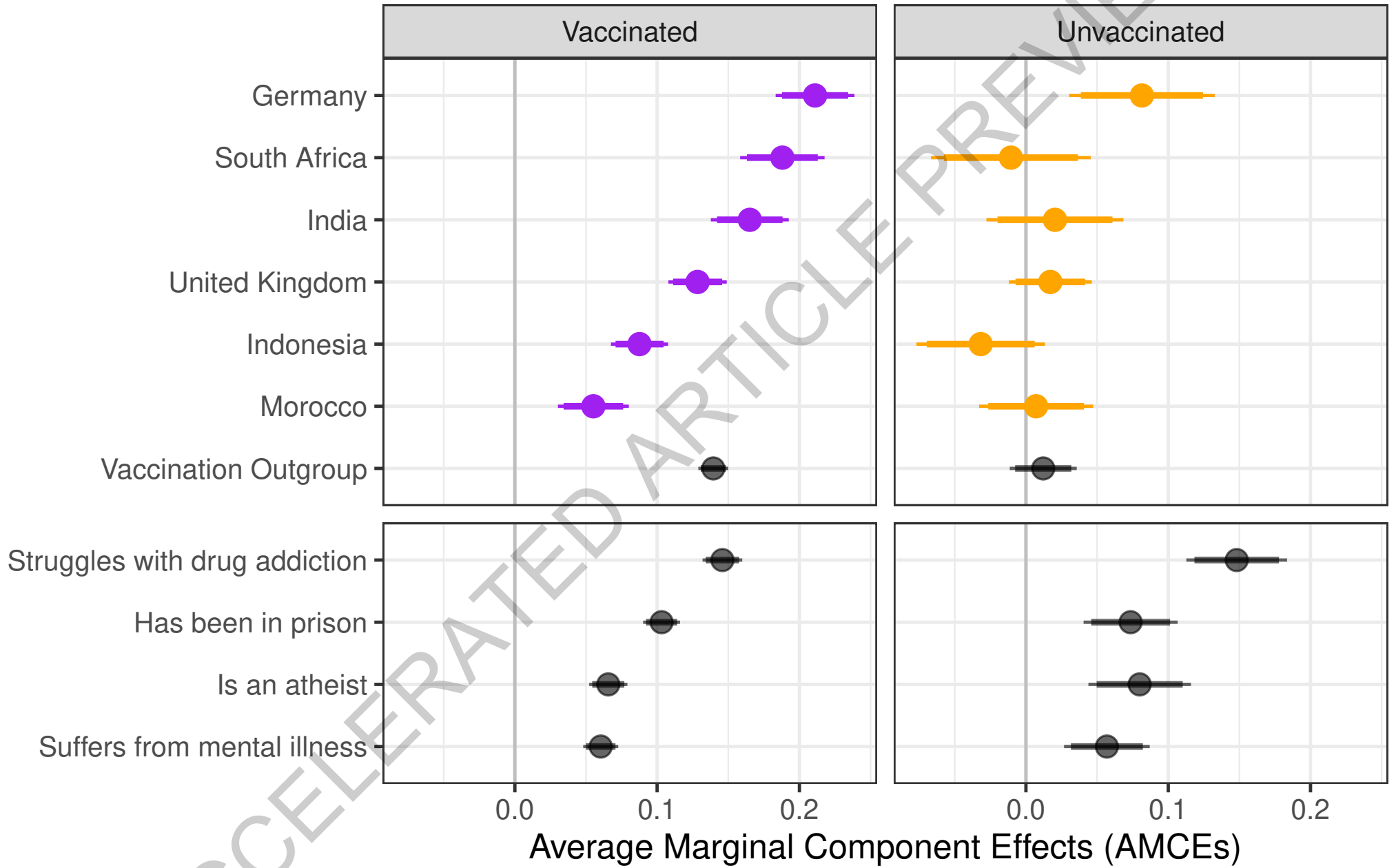
Extended Data Table 3: Studies 2 & 3 – Attributes and levels in the conjoint experiment

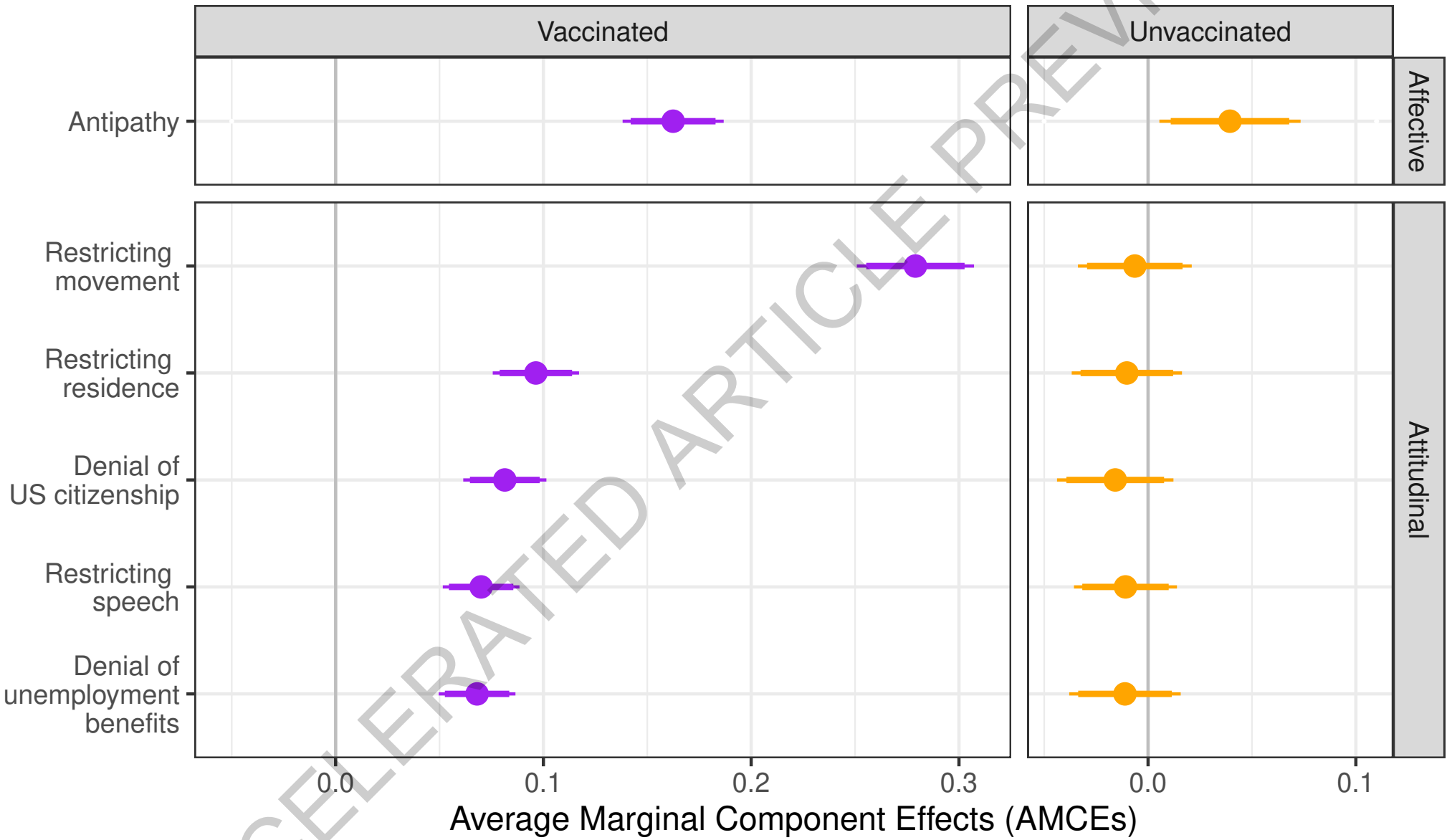
Note: Numbers in parentheses denote the number of levels.

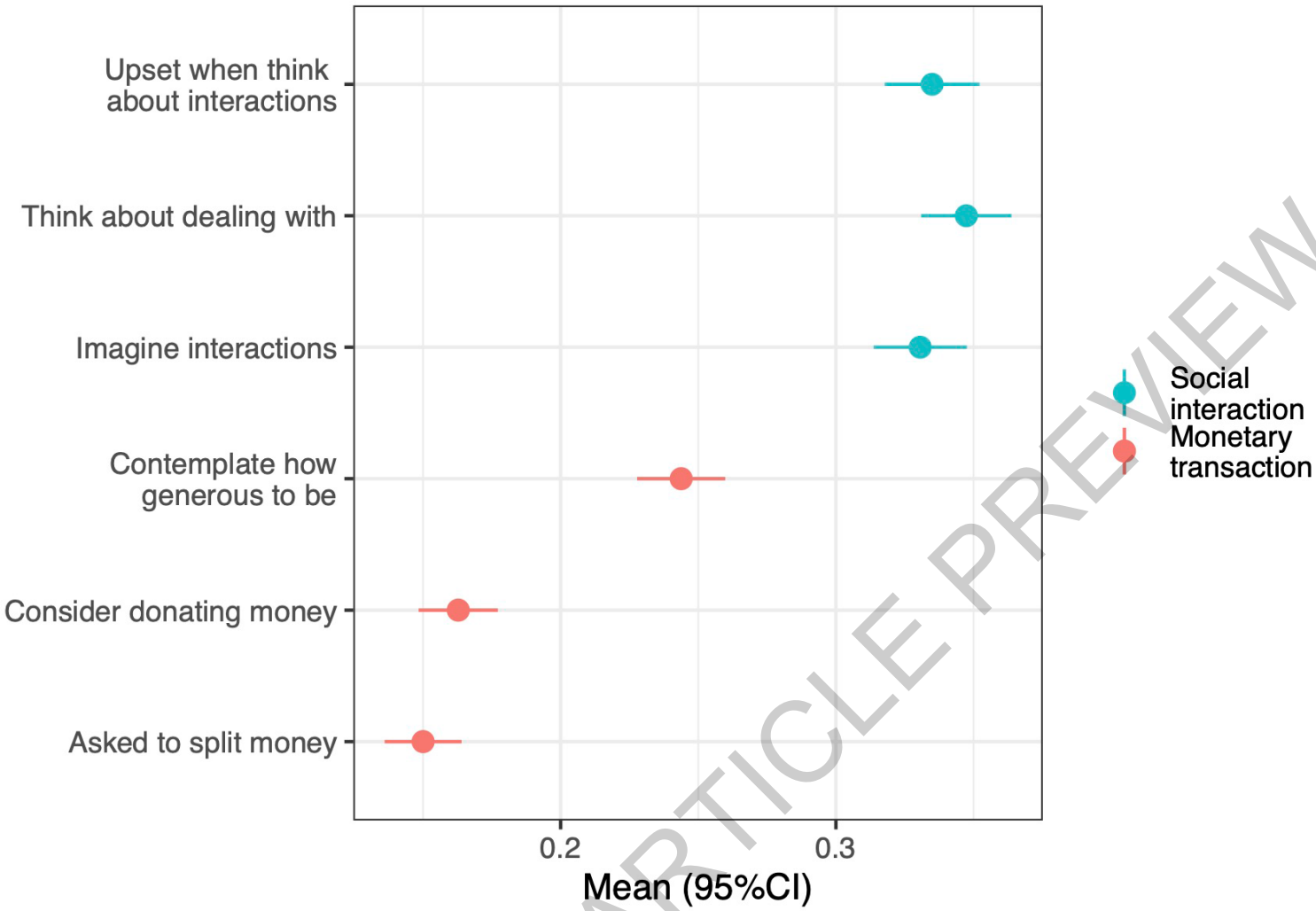




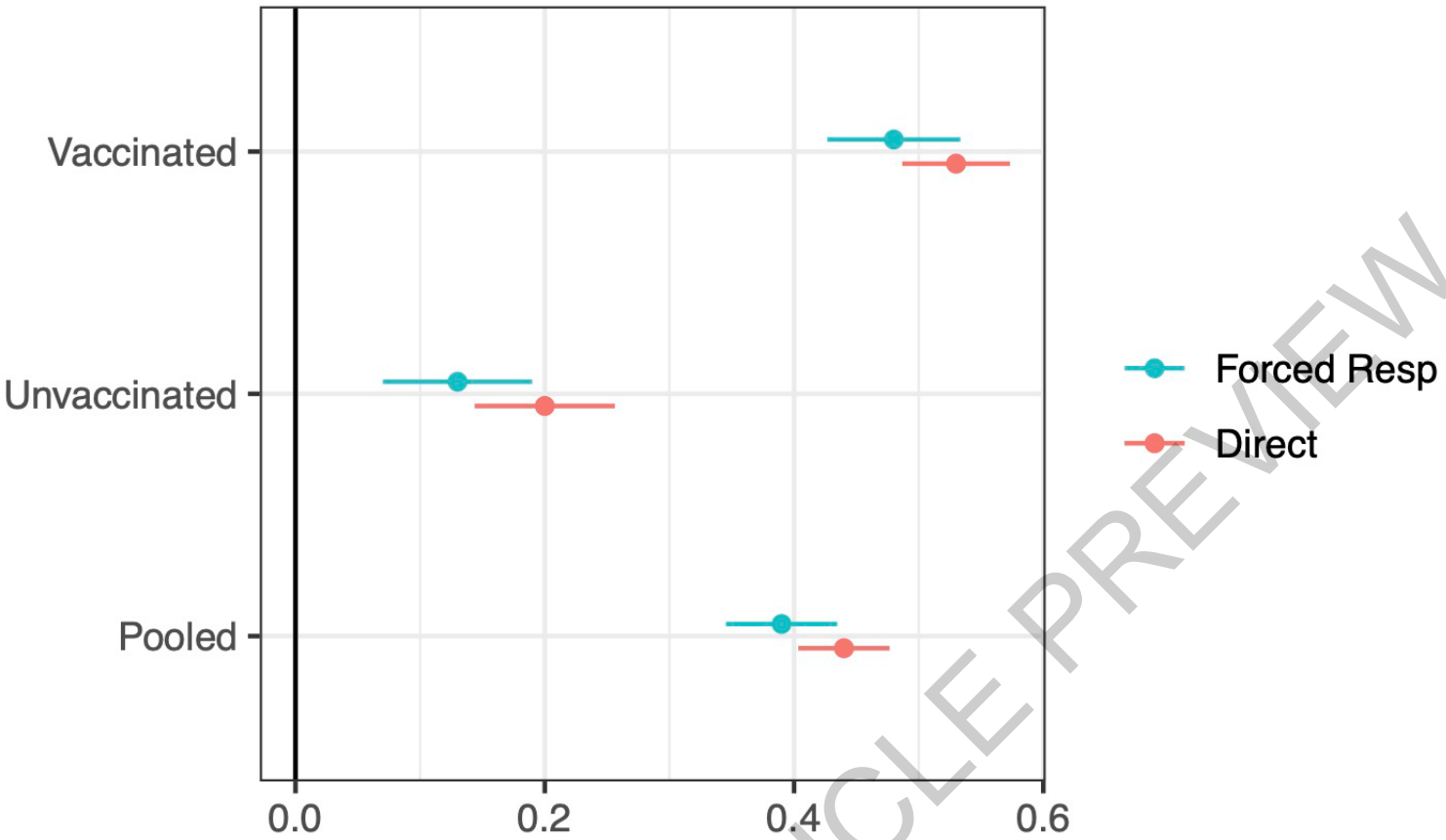








Extended Data Fig. 1



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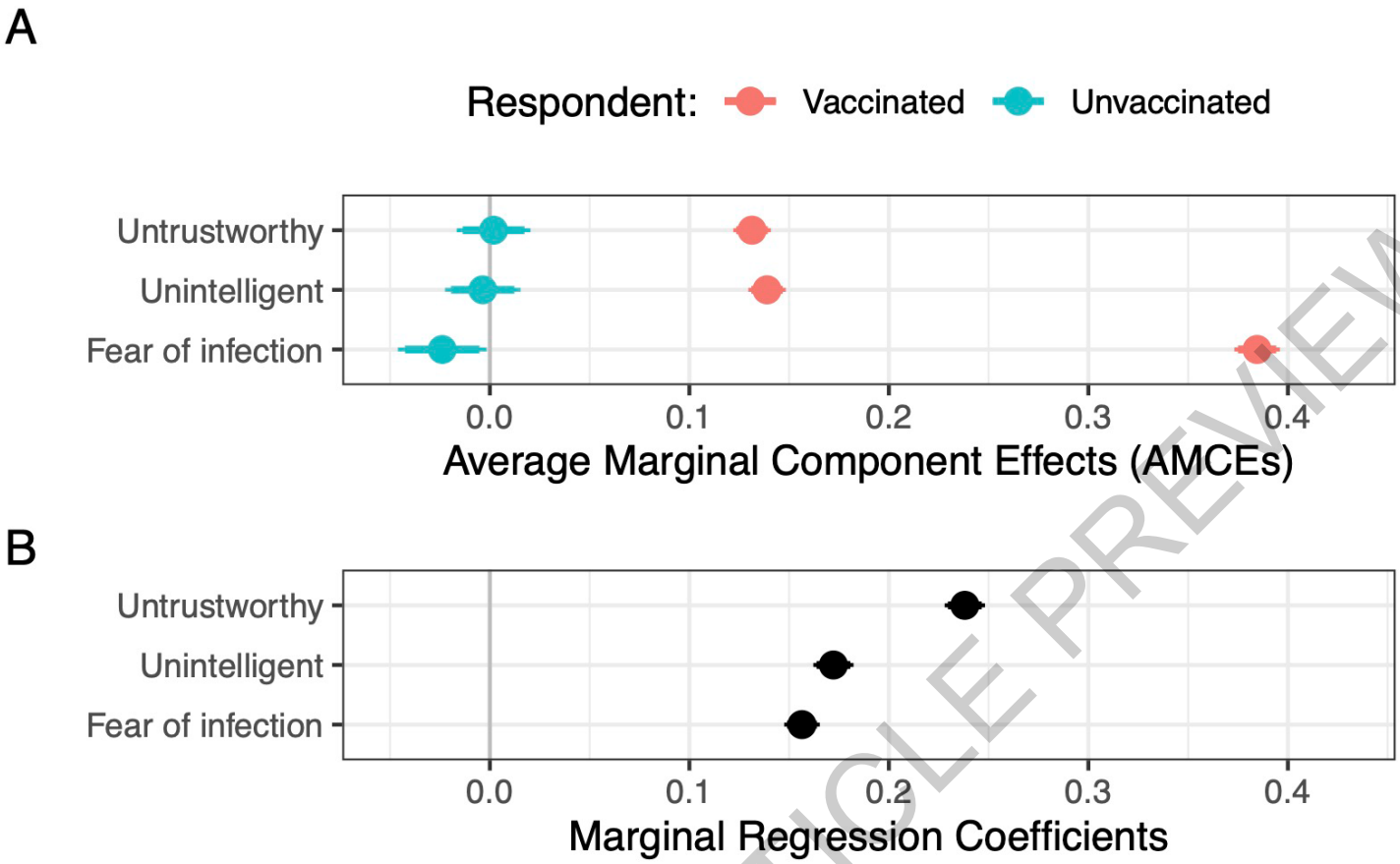

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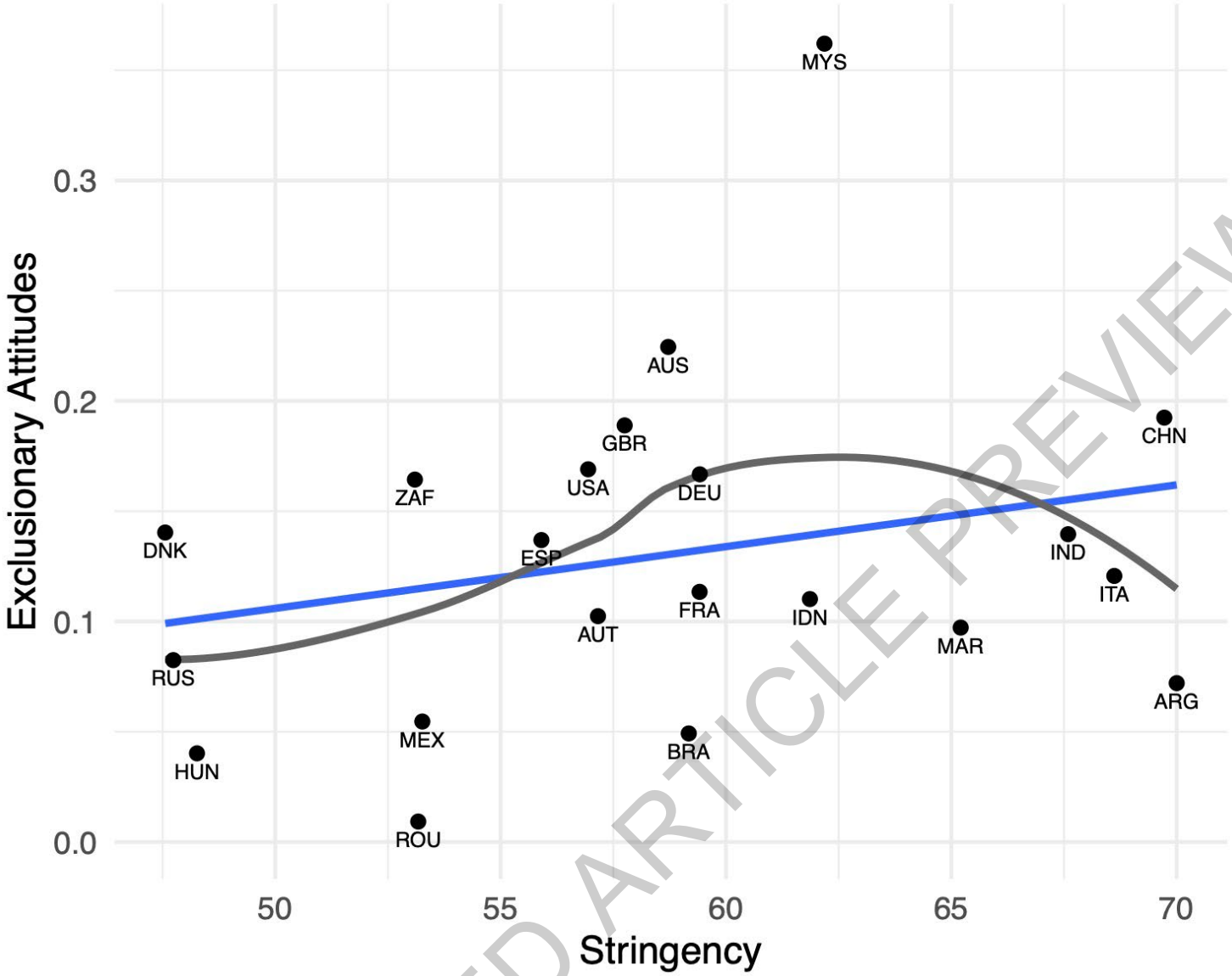

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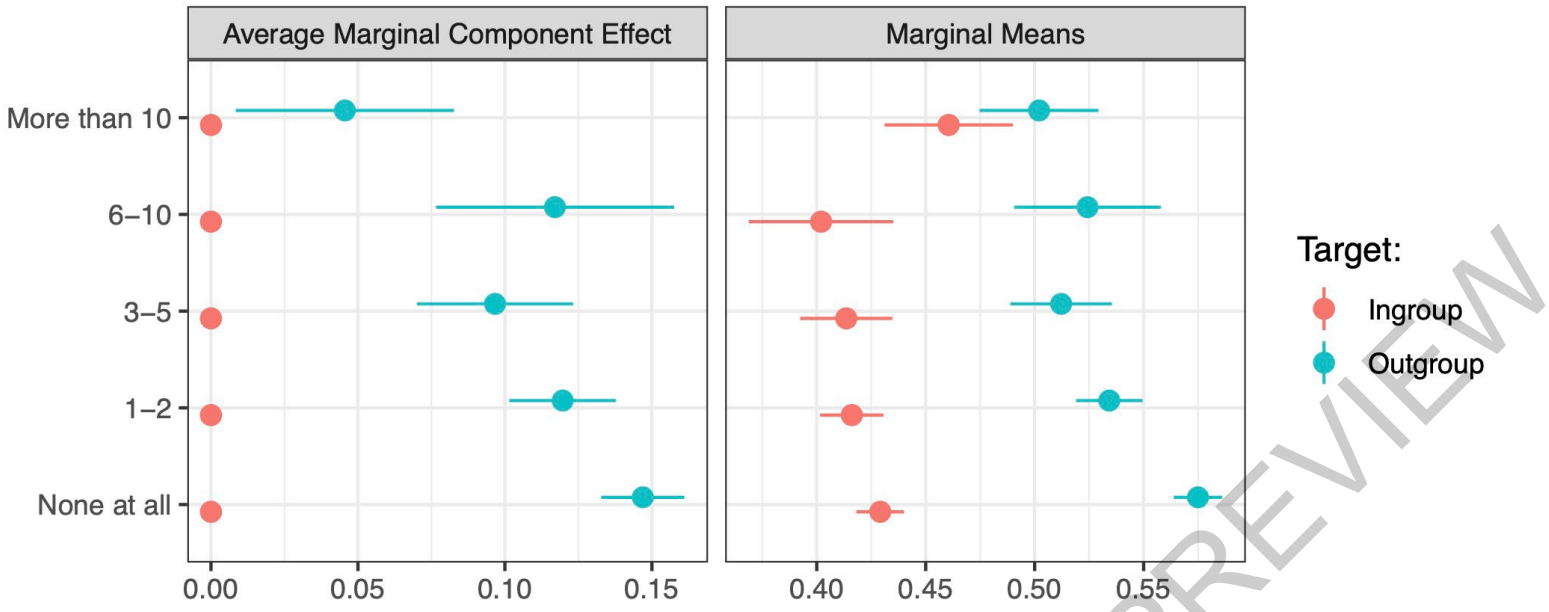

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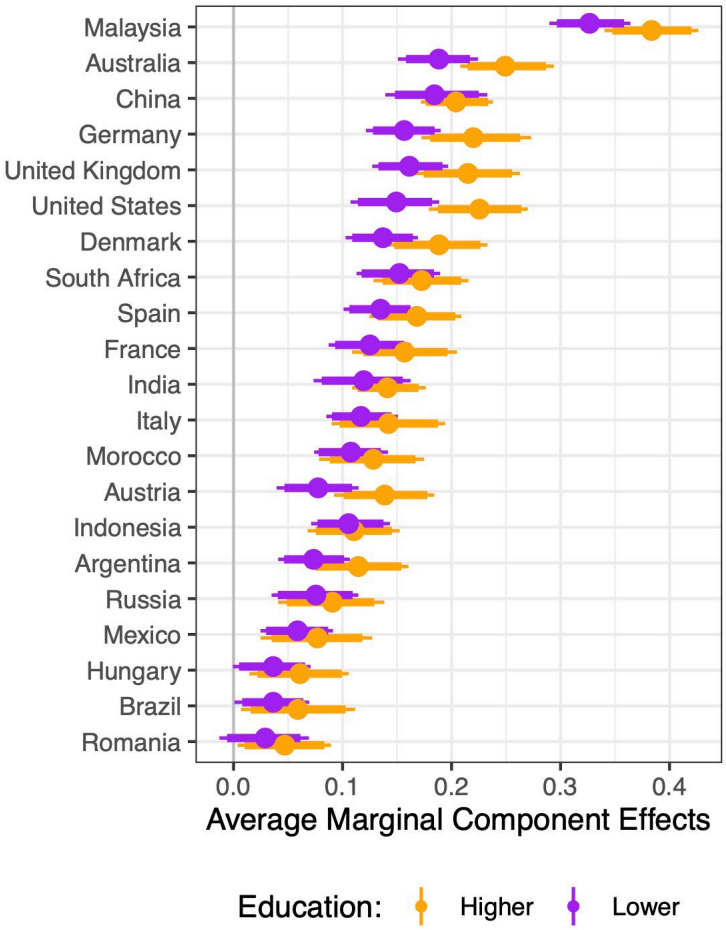

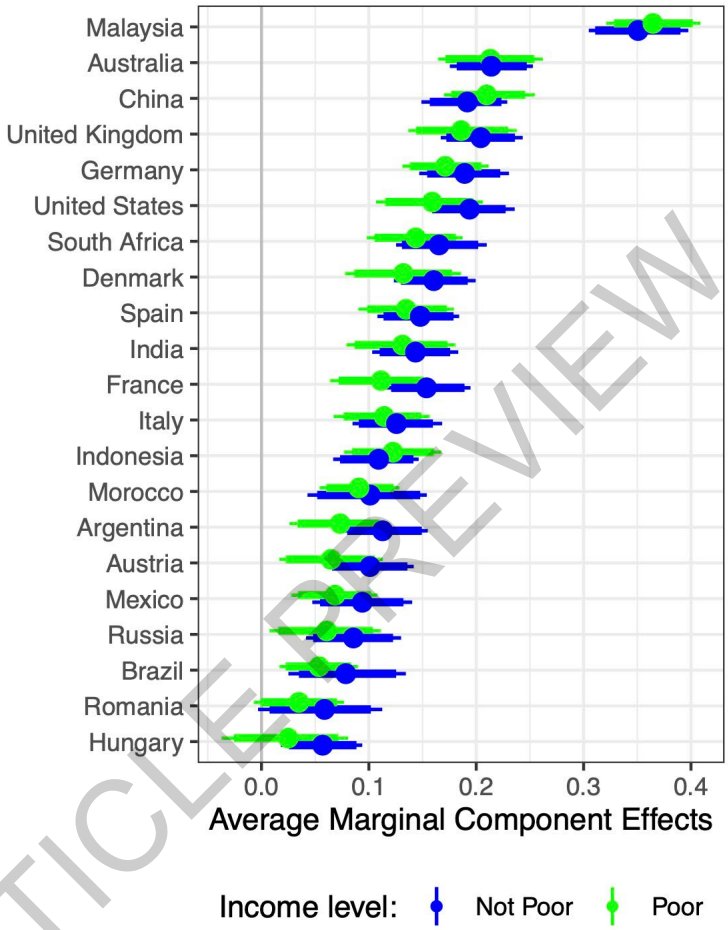

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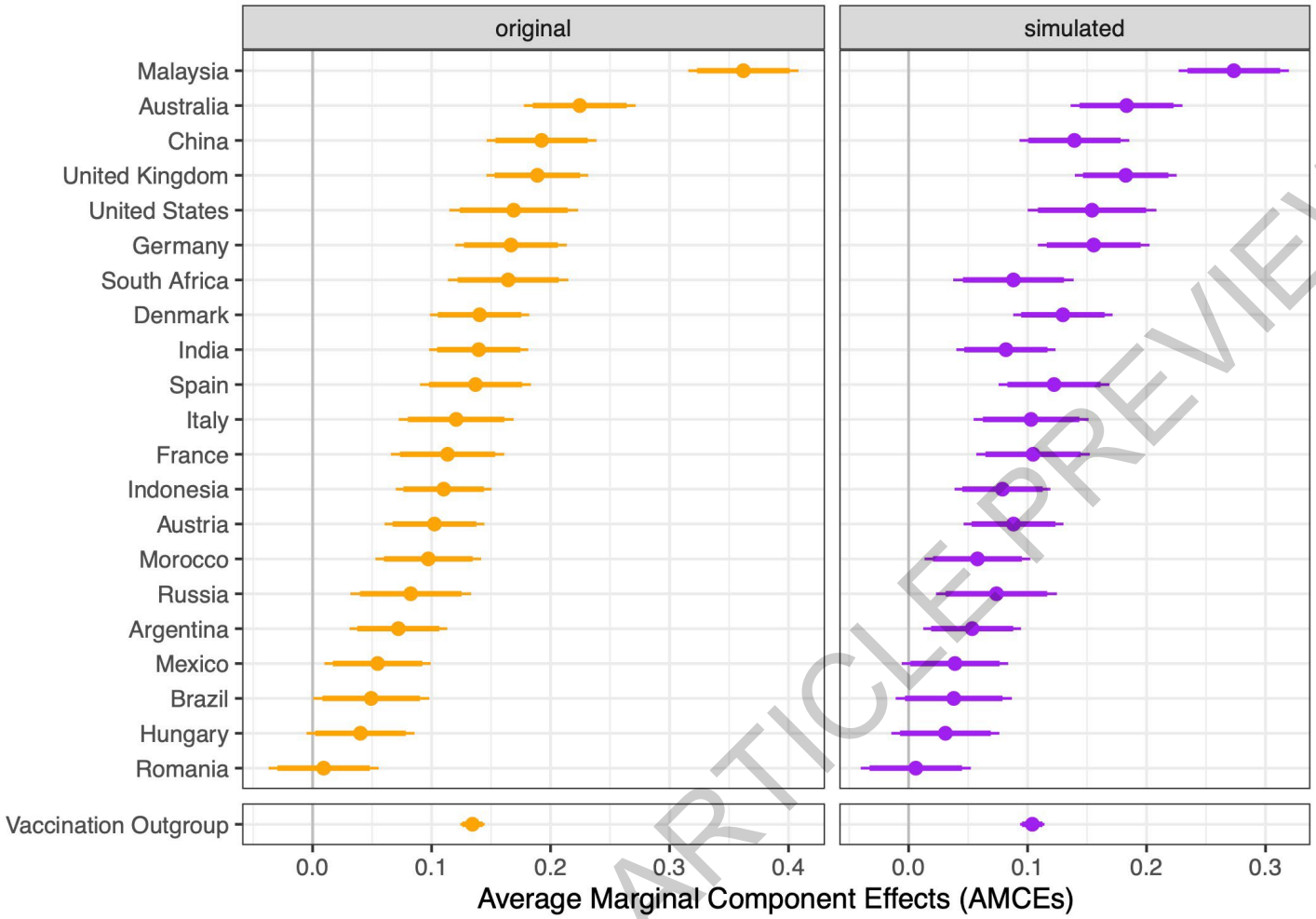

Extended Data Fig. 7

Country	N.obs	Median Age	Women	Higher Ed.	Income–Poor	Income–NA
Argentina	3090	38-42	0.48	0.19	0.41	0.28
Australia	3042	43-47	0.51	0.37	0.32	0.18
Austria	3054	48-52	0.52	0.34	0.33	0.22
Brazil	3036	38-42	0.52	0.21	0.77	0.15
China	3006	25-34	0.44	0.78	0.52	0.04
Denmark	3036	48-52	0.51	0.27	0.18	0.22
France	3054	48-52	0.52	0.31	0.44	0.12
Germany	3054	48-52	0.51	0.21	0.52	0.15
Hungary	3054	43-47	0.53	0.29	0.20	0.07
India	3174	33-37	0.50	0.78	0.22	0.28
Indonesia	3048	28-32	0.46	0.40	0.43	0.05
Italy	3042	48-52	0.52	0.16	0.42	0.22
Malaysia	3078	28-32	0.58	0.42	0.46	0.17
Mexico	3042	38-42	0.52	0.21	0.58	0.18
Morocco	3114	23-27	0.36	0.28	0.70	0.24
Romania	3054	43-47	0.52	0.47	0.71	0.18
Russia	3252	43-47	0.56	0.26	0.43	0.11
South Africa	3042	33-37	0.51	0.43	0.47	0.07
Spain	3036	48-52	0.51	0.40	0.38	0.15
United Kingdom	3108	48-52	0.52	0.33	0.27	0.21
United States	3024	48-52	0.52	0.35	0.38	0.14

Extended Data Table 1

Attributes	Levels
Vaccination against COVID-19 (2)	Fully Vaccinated, Unvaccinated
Family Background (2)	Born and raised in {...}, Immigrated from the Middle East
Age (6)	21, 27, 33, 39, 45, 51
Occupation (6)	Lawyer, High school teacher, Construction inspector, Factory worker, Web developer, Retail salesperson
Hobbies (6)	Movies and TV series, Running and hiking, Reading books, Traveling, Cooking and gastronomy, Music and concerts
Personality (5)	Extrovert and sociable, Has a vivid imagination, Thorough and meticulous, Kind and considerate, Good at staying cool under stress

Extended Data Table 2

Attributes	Levels
Vaccination against COVID-19 (2)	Fully Vaccinated, Unvaccinated
Personal Information (5)	No additional information, Struggles with drug addiction, Suffers from mental illness, Is an atheist, Has been in prison
Age (6)	27, 33, 39, 45, 51, 57
Occupation (5)	Administrator, Construction inspector, Factory worker, Web developer, Retail salesperson
Hobbies (6)	Movies and TV series, Running and hiking, Reading books, Traveling, Cooking and gastronomy, Music and concerts
Personality (5)	Extrovert and sociable, Has a vivid imagination, Thorough and meticulous, Kind and considerate, Good at staying cool under stress

Extended Data Table 3

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Corresponding author(s): Alexander Bor & Michael Bang Petersen

Last updated by author(s): Nov 14, 2022

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☒	☐ A description of all covariates tested
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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

Data was collected by YouGov survey agency with their in house platform in all cases, except for Chinese data in S1, which was collected by Ipsos.

Data analysis

```
R version 4.2.1 (2022-06-23)
Platform: x86_64-apple-darwin17.0 (64-bit)
Running under: macOS Monterey 12.6.1

Matrix products: default
LAPACK: /Library/Frameworks/R.framework/Versions/4.2/Resources/lib/libRlapack.dylib

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[7] base

other attached packages:
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All studies must disclose on these points even when the disclosure is negative.

Sample size	*Describe how sample size was determined, detailing any statistical methods used to predetermine sample size OR if no sample-size calculation was performed, describe how sample sizes were chosen and provide a rationale for why these sample sizes are sufficient.*
Data exclusions	*Describe any data exclusions. If no data were excluded from the analyses, state so OR if data were excluded, describe the exclusions and the rationale behind them, indicating whether exclusion criteria were pre-established.*
Replication	*Describe the measures taken to verify the reproducibility of the experimental findings. If all attempts at replication were successful, confirm this OR if there are any findings that were not replicated or cannot be reproduced, note this and describe why.*
Randomization	*Describe how samples/organisms/participants were allocated into experimental groups. If allocation was not random, describe how covariates were controlled OR if this is not relevant to your study, explain why.*
Blinding	*Describe whether the investigators were blinded to group allocation during data collection and/or analysis. If blinding was not possible, describe why OR explain why blinding was not relevant to your study.*

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	Quantitative conjoint experiments implemented in online surveys.
Research sample	Participants were recruited from large online panels maintained by YouGov (for 20/21 countries) and Ipsos (in China) in S1. In S2 and S3, all data was from YouGov. We recruited at least 500 adult respondents from each country. In our pre-registration, we report a detailed power analysis. It demonstrates that 500 respondents (3,000 observations) per country yields 80% power to detect a main effect of 5 percentage points, and 95% power to detect an effect of 6 points. We judged 5 percentage point as the minimal effect size of interest. Studies 2-3 followed same strategy, although S3 was deliberately overpowered. The data collection used quota sampling on age, gender, and region of residence to ensure representativeness on these variables, and – conditional on feasibility – also education (in Australia, Brazil, Denmark, France, Germany, Italy, Mexico, Russia, Spain, UK, and US) and race (in the US). Quotas were always set to mimic the national population, except in Indonesia, Morocco, and Malaysia, where due to feasibility issues, they are set to the demographic characteristics of the online population and, in India, where they are set to the demographic characteristics of the national urban population. We provide detailed demographic information in Extended Data Table 1 for S1 and Supplementary Section A for S2 and S3.
Sampling strategy	The survey providers employed quota to ensure that the sample composition is "representative" of the wider population. Specifically, the data collection used quota sampling on age, gender, and region of residence, and – conditional on feasibility – also education (in Australia, Brazil, Denmark, France, Germany, Italy, Mexico, Russia, Spain, UK, and US) and race (in the US). Quotas were always set to mimic the national population, except in Indonesia, Morocco, and Malaysia, where due to feasibility issues, they are set to the demographic characteristics of the online population and, in India, where they are set to the demographic characteristics of the

	national urban population. We recruited at least 500 adult respondents from each country. In our pre-registration, we report a detailed power analysis. It demonstrates that 500 respondents (3,000 observations) per country yields 80% power to detect a main effect of 5 percentage points, and 95% power to detect an effect of 6 points. We judged 5 percentage point as the minimal effect size of interest. Studies 2-3 followed same strategy, although S3 was deliberately overpowered.
Data collection	The surveys were administered by third party companies, YouGov and Ipsos. As such, data was collected exclusively through double blind online surveys.
Timing	We collected data between December 3, 2021 and January 28, 2022 for Study 1. Studies 2-3 were collected simultaneously in May 2022.
Data exclusions	No data was excluded from the analyses, but only participants who passed a simple screener (weeding out bots) were allowed to participate in the experiment.
Non-participation	Study specific response rates were not shared by the survey providers (YouGov and Ipsos).
Randomization	The target profiles which participants rated in our experiment were generated completely at random. However, all participants read and responded to all questions.

Ecological, evolutionary & environmental sciences study design

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Study description	*Briefly describe the study. For quantitative data include treatment factors and interactions, design structure (e.g. factorial, nested, hierarchical), nature and number of experimental units and replicates.*
Research sample	*Describe the research sample (e.g. a group of tagged Passer domesticus, all Stenocereus thurberi within Organ Pipe Cactus National Monument), and provide a rationale for the sample choice. When relevant, describe the organism taxa, source, sex, age range and any manipulations. State what population the sample is meant to represent when applicable. For studies involving existing datasets, describe the data and its source.*
Sampling strategy	*Note the sampling procedure. Describe the statistical methods that were used to predetermine sample size OR if no sample-size calculation was performed, describe how sample sizes were chosen and provide a rationale for why these sample sizes are sufficient.*
Data collection	*Describe the data collection procedure, including who recorded the data and how.*
Timing and spatial scale	*Indicate the start and stop dates of data collection, noting the frequency and periodicity of sampling and providing a rationale for these choices. If there is a gap between collection periods, state the dates for each sample cohort. Specify the spatial scale from which the data are taken*
Data exclusions	*If no data were excluded from the analyses, state so OR if data were excluded, describe the exclusions and the rationale behind them, indicating whether exclusion criteria were pre-established.*
Reproducibility	*Describe the measures taken to verify the reproducibility of experimental findings. For each experiment, note whether any attempts to repeat the experiment failed OR state that all attempts to repeat the experiment were successful.*
Randomization	*Describe how samples/organisms/participants were allocated into groups. If allocation was not random, describe how covariates were controlled. If this is not relevant to your study, explain why.*
Blinding	*Describe the extent of blinding used during data acquisition and analysis. If blinding was not possible, describe why OR explain why blinding was not relevant to your study.*

Did the study involve field work? ☐ Yes ☐ No

Field work, collection and transport

Field conditions	*Describe the study conditions for field work, providing relevant parameters (e.g. temperature, rainfall).*
Location	*State the location of the sampling or experiment, providing relevant parameters (e.g. latitude and longitude, elevation, water depth).*
Access & import/export	*Describe the efforts you have made to access habitats and to collect and import/export your samples in a responsible manner and in compliance with local, national and international laws, noting any permits that were obtained (give the name of the issuing authority, the date of issue, and any identifying information).*
Disturbance	*Describe any disturbance caused by the study and how it was minimized.*

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☐	☒ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Antibodies

Antibodies used — *Describe all antibodies used in the study; as applicable, provide supplier name, catalog number, clone name, and lot number.*

Validation — *Describe the validation of each primary antibody for the species and application, noting any validation statements on the manufacturer's website, relevant citations, antibody profiles in online databases, or data provided in the manuscript.*

Eukaryotic cell lines

Policy information about cell lines

Cell line source(s) — *State the source of each cell line used.*

Authentication — *Describe the authentication procedures for each cell line used OR declare that none of the cell lines used were authenticated.*

Mycoplasma contamination — *Confirm that all cell lines tested negative for mycoplasma contamination OR describe the results of the testing for mycoplasma contamination OR declare that the cell lines were not tested for mycoplasma contamination.*

Commonly misidentified lines (See ICLAC register) — *Name any commonly misidentified cell lines used in the study and provide a rationale for their use.*

Palaeontology and Archaeology

Specimen provenance — *Provide provenance information for specimens and describe permits that were obtained for the work (including the name of the issuing authority, the date of issue, and any identifying information). Permits should encompass collection and, where applicable, export.*

Specimen deposition — *Indicate where the specimens have been deposited to permit free access by other researchers.*

Dating methods — *If new dates are provided, describe how they were obtained (e.g. collection, storage, sample pretreatment and measurement), where they were obtained (i.e. lab name), the calibration program and the protocol for quality assurance OR state that no new dates are provided.*

☐ Tick this box to confirm that the raw and calibrated dates are available in the paper or in Supplementary Information.

Ethics oversight — *Identify the organization(s) that approved or provided guidance on the study protocol, OR state that no ethical approval or guidance was required and explain why not.*

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

Animals and other organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research

Laboratory animals — *For laboratory animals, report species, strain, sex and age OR state that the study did not involve laboratory animals.*

Wild animals — *Provide details on animals observed in or captured in the field; report species, sex and age where possible. Describe how animals were caught and transported and what happened to captive animals after the study (if killed, explain why and describe method; if released, say where and when) OR state that the study did not involve wild animals.*

Field-collected samples — *For laboratory work with field-collected samples, describe all relevant parameters such as housing, maintenance, temperature, photoperiod and end-of-experiment protocol OR state that the study did not involve samples collected from the field.*

Ethics oversight — *Identify the organization(s) that approved or provided guidance on the study protocol, OR state that no ethical approval or guidance was required and explain why not.*

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

Human research participants

Policy information about studies involving human research participants

Population characteristics	See above.
Recruitment	Third party survey companies, YouGov and Ipsos, recruited samples as described above on the sampling strategy. With samples recruited online, asymmetry in prejudice between online and offline populations could be a potential source of bias. That said, because the share of offline populations is small and declining in virtually all countries, and because we have no theoretical reasons to expect any such asymmetries in discriminatory attitudes we consider this bias to be minimal (see more details in SI Section O2). Insofar as some of our respondents falsely claim to be vaccinated, our estimates of prejudice towards the unvaccinated are likely to be too conservative.
Ethics oversight	This study fully complies with Aarhus University's Code of Conduct and with the ethical standards set by the Danish Code of Conduct for Research Integrity. As per section 14(2) of the Act on Research Ethics Review of Health Research Projects, ``notification of questionnaire surveys ... to the system of research ethics committee system is only required if the project involves human biological material." All participants provided informed consent and were reimbursed according to their standing agreements with the data provider.

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

Clinical data

Policy information about clinical studies

All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration	*Provide the trial registration number from ClinicalTrials.gov or an equivalent agency.*
Study protocol	*Note where the full trial protocol can be accessed OR if not available, explain why.*
Data collection	*Describe the settings and locales of data collection, noting the time periods of recruitment and data collection.*
Outcomes	*Describe how you pre-defined primary and secondary outcome measures and how you assessed these measures.*

Dual use research of concern

Policy information about dual use research of concern

Hazards

Could the accidental, deliberate or reckless misuse of agents or technologies generated in the work, or the application of information presented in the manuscript, pose a threat to:

No	Yes	
☒	☐	Public health
☒	☐	National security
☒	☐	Crops and/or livestock
☒	☐	Ecosystems
☒	☐	Any other significant area

Experiments of concern

Does the work involve any of these experiments of concern:

No	Yes	
☒	☐	Demonstrate how to render a vaccine ineffective
☒	☐	Confer resistance to therapeutically useful antibiotics or antiviral agents
☒	☐	Enhance the virulence of a pathogen or render a nonpathogen virulent
☒	☐	Increase transmissibility of a pathogen
☒	☐	Alter the host range of a pathogen
☒	☐	Enable evasion of diagnostic/detection modalities
☒	☐	Enable the weaponization of a biological agent or toxin
☒	☐	Any other potentially harmful combination of experiments and agents

ChIP-seq

Data deposition

☐ Confirm that both raw and final processed data have been deposited in a public database such as GEO.

☐ Confirm that you have deposited or provided access to graph files (e.g. BED files) for the called peaks.

Data access links *May remain private before publication.*	*For "Initial submission" or "Revised version" documents, provide reviewer access links. For your "Final submission" document, provide a link to the deposited data.*
Files in database submission	*Provide a list of all files available in the database submission.*
Genome browser session (e.g. UCSC)	*Provide a link to an anonymized genome browser session for "Initial submission" and "Revised version" documents only, to enable peer review. Write "no longer applicable" for "Final submission" documents.*

Methodology

Replicates	*Describe the experimental replicates, specifying number, type and replicate agreement.*
Sequencing depth	*Describe the sequencing depth for each experiment, providing the total number of reads, uniquely mapped reads, length of reads and whether they were paired- or single-end.*
Antibodies	*Describe the antibodies used for the ChIP-seq experiments; as applicable, provide supplier name, catalog number, clone name, and lot number.*
Peak calling parameters	*Specify the command line program and parameters used for read mapping and peak calling, including the ChIP, control and index files used.*
Data quality	*Describe the methods used to ensure data quality in full detail, including how many peaks are at FDR 5% and above 5-fold enrichment.*
Software	*Describe the software used to collect and analyze the ChIP-seq data. For custom code that has been deposited into a community repository, provide accession details.*

Flow Cytometry

Plots

Confirm that:

☐ The axis labels state the marker and fluorochrome used (e.g. CD4-FITC).

☐ The axis scales are clearly visible. Include numbers along axes only for bottom left plot of group (a 'group' is an analysis of identical markers).

☐ All plots are contour plots with outliers or pseudocolor plots.

☐ A numerical value for number of cells or percentage (with statistics) is provided.

Methodology

Sample preparation	*Describe the sample preparation, detailing the biological source of the cells and any tissue processing steps used.*
Instrument	*Identify the instrument used for data collection, specifying make and model number.*
Software	*Describe the software used to collect and analyze the flow cytometry data. For custom code that has been deposited into a community repository, provide accession details.*
Cell population abundance	*Describe the abundance of the relevant cell populations within post-sort fractions, providing details on the purity of the samples and how it was determined.*
Gating strategy	*Describe the gating strategy used for all relevant experiments, specifying the preliminary FSC/SSC gates of the starting cell population, indicating where boundaries between "positive" and "negative" staining cell populations are defined.*

☐ Tick this box to confirm that a figure exemplifying the gating strategy is provided in the Supplementary Information.

Magnetic resonance imaging

Experimental design

Design type	*Indicate task or resting state; event-related or block design.*

Design specifications

Specify the number of blocks, trials or experimental units per session and/or subject, and specify the length of each trial or block (if trials are blocked) and interval between trials.

Behavioral performance measures

State number and/or type of variables recorded (e.g. correct button press, response time) and what statistics were used to establish that the subjects were performing the task as expected (e.g. mean, range, and/or standard deviation across subjects).

Acquisition

Imaging type(s)

Specify: functional, structural, diffusion, perfusion.

Field strength

Specify in Tesla

Sequence & imaging parameters

Specify the pulse sequence type (gradient echo, spin echo, etc.), imaging type (EPI, spiral, etc.), field of view, matrix size, slice thickness, orientation and TE/TR/flip angle.

Area of acquisition

State whether a whole brain scan was used OR define the area of acquisition, describing how the region was determined.

Diffusion MRI ☐ Used ☐ Not used

Preprocessing

Preprocessing software

Provide detail on software version and revision number and on specific parameters (model/functions, brain extraction, segmentation, smoothing kernel size, etc.).

Normalization

If data were normalized/standardized, describe the approach(es): specify linear or non-linear and define image types used for transformation OR indicate that data were not normalized and explain rationale for lack of normalization.

Normalization template

Describe the template used for normalization/transformation, specifying subject space or group standardized space (e.g. original Talairach, MNI305, ICBM152) OR indicate that the data were not normalized.

Noise and artifact removal

Describe your procedure(s) for artifact and structured noise removal, specifying motion parameters, tissue signals and physiological signals (heart rate, respiration).

Volume censoring

Define your software and/or method and criteria for volume censoring, and state the extent of such censoring.

Statistical modeling & inference

Model type and settings

Specify type (mass univariate, multivariate, RSA, predictive, etc.) and describe essential details of the model at the first and second levels (e.g. fixed, random or mixed effects; drift or auto-correlation).

Effect(s) tested

Define precise effect in terms of the task or stimulus conditions instead of psychological concepts and indicate whether ANOVA or factorial designs were used.

Specify type of analysis: ☐ Whole brain ☐ ROI-based ☐ Both

Statistic type for inference
(See Eklund et al. 2016)

Specify voxel-wise or cluster-wise and report all relevant parameters for cluster-wise methods.

Correction

Describe the type of correction and how it is obtained for multiple comparisons (e.g. FWE, FDR, permutation or Monte Carlo).

Models & analysis

n/a	Involved in the study
☐	☐ Functional and/or effective connectivity
☐	☐ Graph analysis
☐	☐ Multivariate modeling or predictive analysis

Functional and/or effective connectivity

Report the measures of dependence used and the model details (e.g. Pearson correlation, partial correlation, mutual information).

Graph analysis

Report the dependent variable and connectivity measure, specifying weighted graph or binarized graph, subject- or group-level, and the global and/or node summaries used (e.g. clustering coefficient, efficiency, etc.).

Multivariate modeling and predictive analysis

Specify independent variables, features extraction and dimension reduction, model, training and evaluation metrics.