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Safety first, but for whom? Shifts in risk perception for self and others following COVID-19 vaccination

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[Correction added on 13 May 2023, after first online publication: The phrase ‘ latter’ in the abstract was replaced with ‘former]

Abstract

Vaccines can affect the mind as well as the body. Research on the psychological impact of vaccines has largely focused on risk-related judgments and behaviors involving the recipient. Here, we extend this work to risk-related judgments of *others*. In a prospective cohort study involving three samples and two timepoints (N = 588 adults), we tested competing hypotheses about the effects of receiving a COVID-19 vaccine on perceived risks to the unvaccinated: (1) a self/other differentiation hypothesis (vaccination will lead to estimation of lower risk for the self but higher risk for others) versus (2) a self/other correspondence hypothesis (vaccination will lead to estimation of lower risk from contracting COVID-19 for both self and others). Results revealed risk estimates as well as preferences for COVID-related social policies more consistent with the former hypothesis. We discuss potential psychological mechanisms and implications of these findings.

KEYWORDS
disease, other, policy, risk perception, self, vaccine

The benefits of vaccination for improving personal and public health have been recognized for over a century, but much less understood are the psychological effects that vaccination may entail. For example, some have suggested that prophylactic measures such as vaccination could have unintended consequences, such as “a false sense of security that can lead to neglecting other essential measures” (World Health Organization, 2020) and asking “as vaccines roll out, will risky behavior increase?" (Doheny, 2021). When questions arise about potential psychological consequences, they almost exclusively target self-directed reactions, such as risky decision-making and behavior, of those individuals using preventive measures (e.g., Ackerman et al., 2021; Choi et al., 2022).

Here, we ask whether vaccination alters how people view and make decisions about *others* in addition to themselves. Imagine that a politician, manager, or school administrator becomes vaccinated and subsequently must decide about policies affecting the safety of their unvaccinated constituents, employees, or students. Shifts in the perceived risks that others face could lead to judgments and decisions that either improve or threaten the health of those unvaccinated others. How might this work in the context of COVID-19 vaccination?

Social psychological literature clearly supports the premise that perceptions of others are influenced by perceiver states (e.g., Dunning & Hayes, 1996; Marks & Miller, 1987). Less clear is the direction of this influence following an experience such as vaccination. We next introduce and test two competing hypotheses of vaccine-related shifts in other-oriented risk perception: self/other differentiation versus self/other correspondence.

H1. *Self/other differentiation*. Vaccination will lower the perceived risk of COVID-19 infection to oneself, but heighten it for others, exaggerating differences in risk perception between self and unvaccinated others.

Multiple psychological processes may lead the vaccinated to view themselves as unique from the unvaccinated. Egocentric biases, including the above/below average effect, spotlight effect, and self-serving bias, involve individuals perceiving themselves as different from (and often better than) others (Chambers et al., 2003; Gilovich & Savitsky, 1999; Kruger, 1999). Unrealistic optimism in particular is exhibited when people judge their own risk of suffering controllable health problems as lower compared to the risks others face (Shepperd et al., 2015). Group-based processes may also lead to differentiation in the context of vaccination. People often perceive ingroup members as more similar to themselves on a variety of dimensions (especially positive ones), but outgroup members as less similar to themselves (Mullen et al., 1992; Vanhoomissen & Van Overwalle, 2010). During the COVID-19 pandemic, vaccination may have acted as a marker of group identity due to its association with U.S. political affiliation (e.g., Druckman et al., 2020). Together, the consequence of such processes would be to exaggerate differences in risk perceptions between those choosing to receive a vaccine and those choosing to decline it.

H2. *Self/other correspondence*. Vaccination will lower perceived risks of COVID-19 infection to oneself, and to others as well, decreasing self/other differences in risk perception between self and unvaccinated other.

Though perhaps a less obvious outcome, certain psychological processes lead perceivers to base their inferences about others on self-relevant evaluations. For example, egocentric biases such as the false consensus effect involve the belief that others share one's knowledge and behavioral choices (Mullen et al., 1985), whereas mood-consistency effects demonstrate that people process and remember information about others more readily when that information is consistent with perceivers' mood (Forgas & Bower, 1987). In the current content, safety beliefs and feelings following vaccination may lead perceivers to judge others to be at lowered risk of disease-related harm. Together, these processes could result in vaccinated people presuming that others are at decreased risk from infection (though likely still estimating greater overall risk for the unvaccinated than the vaccinated).

In the current study, we tested these hypotheses by longitudinally tracking a core group of participants, all of whom were unvaccinated at time 1 and approximately half of whom were vaccinated at time 2, along with two comparison samples, one which was vaccinated at time 1 and one which was unvaccinated at time 2.

1 | METHOD

For preregistration, see: https://aspredicted.org/eh648.pdf. For materials and data, see: https://osf.io/7xkn3/.

1.1 | Participants

Using a prospective cohort design (e.g., Hanquet et al., 2013), we collected data from three U.S. participant sets (Set A, Set B, and Set C) across two time periods (time 1 and time 2) using CloudResearch platform to implement data quality filters when recruiting from Amazon Mechanical Turk. Set A participants were unvaccinated at time 1 and sampled at both time 1 and time 2; Set B participants were vaccinated and sampled at time 1; and Set C participants were unvaccinated and sampled at time 2. Time 1 represents March 23rd - 24th, 2021, and time 2 represents May 21st - 31st, 2021 (see Figure 1). Total population vaccination rates (at least one dose) were 26% on March 23rd and 49% on May 21st (CDC, 2021). We also retrieved data on weekly reported county-level COVID-19 cases per 100,000 people at both times (White House COVID-19 Team, 2021).

1.1.1 | Set A

We recruited 514 unvaccinated participants at time 1 in exchange for $0.90, and solicited responses from the same participants at time 2 in exchange for $1.50. Following preregistered exclusions applied to the returning participants (77% from time 1), the final sample for Set A was 388 people. Participants were 42.87 years old on average (*SD* = 11.36), 57% women (225 women, 156 men), and approximately 24% non-White. At time 2, 206 participants (53%) reported having received at least one vaccine dose.

1.1.2 | Sets B and C

Two additional samples were used to help validate inferences about vaccine-related causality. At time 1, we recruited 101 (99 after exclusions) vaccinated participants (Set B). At time 2, we recruited 108 (101 after exclusions) unvaccinated participants (Set C). Participants from Sets B and C were paid $0.90 ($4.50/hour). See Supporting Material for demographics.

1.2 | Power analysis

Sensitivity power analyses using G*Power (Faul et al., 2007) showed that our sample provided 80% power at a significance level of α = 0.05 to detect an effect size of f = 0.07, a small effect by traditional standards, for the primary

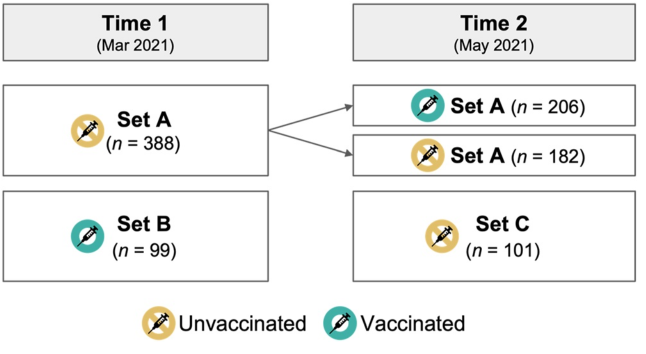

FIGURE 1 Overview of Study Design. Set A is the focal sample for the analyses. Sets B and C were used to help validate causal inferences.

interaction, and the same power to detect effect sizes of d = 0.34 and 0.35 in Set A-B and Set A-C comparisons, respectively.

1.3 | Procedure

After providing informed consent, participants answered questions about perceived risks related to COVID-19. The main questions were identical across waves and sets.

1.3.1 | Outcomes of interest

As our primary outcomes of interest, participants reported how harmful contracting COVID-19 would be to an unvaccinated person ("If the average unvaccinated person caught COVID-19 today, how likely do you think the illness would be to cause severe harm or death?"; −3 = not at all, 3 = extremely likely), and how unpleasant the illness would be ("If the average unvaccinated person caught COVID-19 today, how unpleasant do you think their having the illness would be?"; 0 = not at all unpleasant, 6 = extremely unpleasant). Next, they answered the same questions framed in terms of perceived risks to the self, which serve as reference points against which judgments about risks to others can be evaluated.

For space reasons, additional measures such as questions about COVID-19 regulations, vaccination beliefs, and individual differences in risk and disease sensitivity are reported in the Supporting Materials (see Table S1).

1.4 | Data analytic plan

To distinguish between our hypotheses, two types of self/other comparisons were tested, each of which contrasted judgments for unvaccinated others to judgments for the self. Thus, all references to "others" refer to unvaccinated others. The analyses included mixed analyses of variance: (1) with vaccine status and time predicting change on the harm and unpleasantness items, and (2) on difference scores calculated by subtracting risk estimates for self from risk estimates for others at each time. Subsequently, analyses compared Set A participants (the primary sample) to Sets B and C. In the interest of space, statistics for nonsignificant main effects are not reported. Bonferroni corrections were used to adjust for multiple post hoc comparisons, and differences in degrees of freedom across analyses are due to missing data.

Additionally, we averaged county-level COVID-19 case rates at each time and examined the main questions when controlling for these COVID-19 cases and relevant demographics (age, gender, income, and political party identification). These tests yielded similar conclusions for the higher-order effects reported next, and so we do not include them here.

2 | RESULTS

2.1 | How does receiving a COVID-19 vaccine alter risk perceptions?

If the results support the self/other differentiation hypothesis (H1), we would expect an increase in expected harm severity and unpleasantness for others but a decrease for the self among the vaccinated. This should be reflected by larger self/other difference scores. If instead the results support the self/other correspondence hypothesis (H2), we would expect a drop over time in expected harm severity and unpleasantness for both self and others among vaccinated individuals. However, we would not expect changes over time in self/other difference scores due to both self- and other-estimates declining.

2.1.1 | Pre-to post-vaccination changes in risk estimates

Examining perceived severity of harm from COVID-19 infection, a significant vaccine status×time interaction emerged on other-judgments, F (1,380) = 8.68, p = 0.003, η_p^2 = 0.02 (see Table 1), with vaccinated individuals rating other-harm higher than they did prior to their own vaccination, d = 0.19, SE = 0.09, p = 0.042, 95% confidence interval (CI) [0.01,0.38], and unvaccinated individuals rating other-harm lower than they did at time 1, d = −0.21, SE = 0.10, p = 0.035, 95% CI [-0.41,-0.02]. Additionally, a significant main effect of vaccine status indicated that individuals receiving the vaccine reported higher harm for others at both timepoints compared to unvaccinated individuals, F (1,380) = 21.95, p < 0.001, η_p^2 = 0.06. An interaction also emerged on self-judgments, F (1,375) = 43.54, p < 0.001, η_p^2 = 0.10, with vaccinated individuals lowering their estimates of self-harm after vaccination, d = −1.10, SE = 0.10, p < 0.001, 95% CI [-1.29,-0.91], but unvaccinated individuals not changing their self-estimates, p > 0.05.

Findings for perceived unpleasantness of contracting COVID-19 showed a somewhat different pattern. No vaccine status×time interaction emerged on other-judgments, p = 0.260, with other-unpleasantness remaining unchanged for both vaccinated and unvaccinated participants, ps > 0.05. A main effect of vaccine status did indicate that individuals receiving the vaccine reported higher unpleasantness for others at both timepoints compared to unvaccinated individuals, F (1,384) = 20.52, p < 0.001, η_p^2 = 0.05. Self-judgments appeared similar to those for harm severity. A significant vaccine status×time interaction, F (1, 373) = 45.53, p < 0.001, η_p^2 = 0.11, showed that vaccinated participants estimated unpleasantness for the self to be lower following vaccination, d = −1.14, SE = 0.11, p < 0.001, 95% CI [-1.36,-0.92], whereas unvaccinated participants did not change their estimates, p > 0.05. Overall, this evidence suggests that vaccination does influence other-directed risk perception, in particular for judgments of harm rather than experiential affect.

2.1.2 | Differences between risk estimates for others and the self

We next conducted mixed ANOVAs on the self/other difference scores (calculated as other-self judgments) to compare relative risk perceptions and directly distinguish between our two hypotheses. Because the risk estimates

TABLE 1 Self and other ratings of harm severity and unpleasantness across set and time.

		Harm severity [-3, 3]			
		Self		Other	
Set	Vaccination status	Time 1	Time 2	Time 1	Time 2
A	Vaccinated at T2	−0.23 (1.79)	−1.34 (1.63)	0.00 (1.48)	0.19 (1.61)
	Unvaccinated at T2	−0.86 (1.89)	−1.02 (1.78)	−0.50 (1.71)	−0.72 (1.62)
B	Vaccinated	−0.66 (1.95)	N/A	0.29 (1.54)	N/A
C	Unvaccinated	N/A	−1.07 (1.92)	N/A	−0.89 (1.74)
		Unpleasantness [0, 6]			
		Self		**Other**	
Set	**Vaccination status**	**Time 1**	**Time 2**	**Time 1**	**Time 2**
A	Vaccinated at T2	4.49 (1.43)	3.35 (1.72)	4.32 (1.31)	4.39 (1.36)
	Unvaccinated at T2	3.66 (1.83)	3.61 (1.79)	3.79 (1.66)	3.70 (1.56)
B	Vaccinated	3.69 (1.66)	N/A	4.26 (1.28)	N/A
C	Unvaccinated	N/A	3.46 (1.73)	N/A	3.38 (1.54)

Note: All Set A participants were unvaccinated at T1.

involved negative perceptions, higher scores reflect greater estimation of others' risk relative to one's own—a stronger egoistic bias (Weinstein, 1980).

For harm severity, results revealed significant main effects of vaccine status, F (1,369) = 24.31, $p < 0.001$, $\eta_p^2 = 0.06$, and time, F (1,369) = 50.36, $p < 0.001$, $\eta_p^2 = 0.12$, which were further qualified by an interaction, F (1,369) = 60.13, $p < 0.001$, $\eta_p^2 = 0.14$ (see Figure 2). Self/other difference scores increased over time for vaccinated participants, d = 1.31, SE = 0.12, $p < 0.001$, 95% CI [1.08,1.55], whereas there was no significant change for unvaccinated participants, p = 0.653.

For unpleasantness, results similarly showed significant main effects of vaccine status, F (1,371) = 12.42, $p < 0.001$, $\eta_p^2 = 0.03$, and time, F (1,371) = 47.96, $p < 0.001$, $\eta_p^2 = 0.11$, as well as an interaction, F (1,371) = 50.69, $p < 0.001$, $\eta_p^2 = 0.12$. Self/other difference scores increased over time for vaccinated participants, d = 1.22, SE = 0.12, $p < 0.001$, 95% CI [0.99,1.46], but not for unvaccinated participants, p = 0.893. See the Supporting Material for additional confirmatory tests.

On the whole, multiple tests indicate that self/other distinctions in risk perception (especially for harm severity) grew following vaccination. These patterns provide support primarily for the self/other differentiation hypothesis.

2.1.3 | Comparisons of risk perception for others among sets A, B, and C

Following the prospective cohort design, we conducted additional tests comparing Set A participants (times 1 and 2) to Set B (time 1 only) and Set C (time 2 only) in order to help clarify whether the prior findings were likely due to the passage of time or sampling bias rather than vaccine receipt.

If time primarily accounts for risk perception changes, we would expect (but did not find support for) three types of outcomes. First, vaccination status in Set A (time 2) participants should have little effect on outcomes (i.e., wave changes should be consistent across vaccination status). Instead, the tests reported previously show that risk perceptions differed significantly as a function of Set A vaccination status. Second, vaccinated Set A (time 2) judgments should be different from people vaccinated at an earlier time (Set B). However, independent sample t-tests showed no signifi-

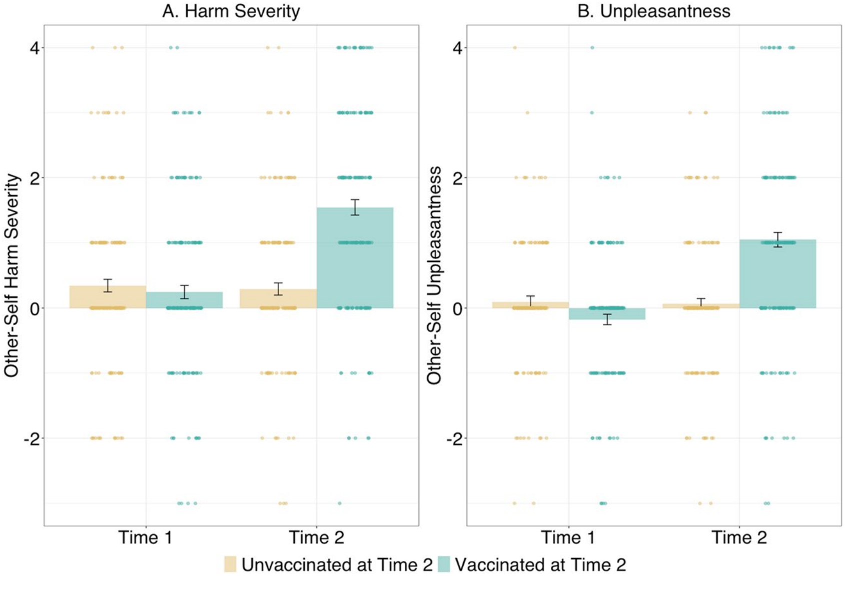

FIGURE 2 Self/Other Difference Scores Between Vaccinated and Unvaccinated Individuals Over Time. Other-self difference scores are presented on the y axis, with that range set from −3 to 4 for ease of viewing. This omits approximately 2% of all data points, 14 points for panel A and 12 points for panel B, from the figure. All Set A participants were unvaccinated at time 1.

cant differences in harm or unpleasantness ratings between these groups, *ps* > 0.05. Third, vaccinated Set A (time 2) judgments should be similar to those from unvaccinated participants assessed at the same time period (Set C). But those Set A participants reported greater harm severity and unpleasantness to others than did Set C participants, (respectively) t (304) = 5.33, $p < 0.001$, 95% CI [0.68,1.47], $d = 0.65$ and t (303) = 5.81, $p < 0.001$, 95% CI [0.67,1.35], $d = 0.71$.

If the results were instead due to sampling bias, such that unvaccinated Set A participants were somehow unique from other unvaccinated people, those Set A (time 2) participant judgments should differ from judgments of Set C (unvaccinated) participants. This was not the case for either harm severity or unpleasantness ratings, *ps* > 0.05.

Together, these effects suggest that vaccination, and not merely the passage of time or sampling bias, is associated with perceiving greater COVID-related harm (and perhaps unpleasantness) to others.

2.1.4 | Additional findings

In the Supporting Materials, we report analyses of two additional types of measures addressing whether (1) the vaccination effect on risk estimates for unvaccinated others is unique to COVID-19 risks, and (2) receiving a COVID-19 vaccine alters support for preventive actions such as government regulations. We find that vaccination appears to have altered only COVID-related risk perception, and that although both groups advocated for fewer preventive actions over time, vaccinated people changed more than unvaccinated people did (see Figure S1).

3 | DISCUSSION

Did COVID-19 vaccination lead to lower risk estimates for the self but higher risk estimates for unvaccinated others (self/other differentiation hypothesis), or lower risk estimates for both self and unvaccinated others (self/other correspondence hypothesis)? Our results were most consistent with the self/other differentiation hypothesis. After vaccination, individuals decreased risk estimates for themselves and increased risk estimates for others compared to pre-vaccination (in particular, estimates of harm severity). In contrast, unvaccinated participants decreased their harm estimates for others but otherwise did not change their assessments. Analyses with self/other difference scores further indicated that the gap in risk estimates between self and others became larger over time among the vaccinated. Presumably, vaccinated individuals felt safer because of their immunization, but this sense of safety did not extend to unvaccinated others. Examining subsequent beliefs about COVID-19 restrictions, vaccinated individuals perceived greater risk to others, but they also increased their support for relaxing regulations and return-to-normal plans.

Several, not mutually exclusive, psychological processes may be implicated by the vaccination differentiation hypothesis. Optimistic biases—underestimating one's own risk but overestimating that of others—are well-documented in domains such as negative health events (Weinstein, 1982), smoking (Segerstrom et al., 1993), and others (Klein & Helweg-Larsen, 2002; Park et al., 2014). A sense of safety after vaccination may have exaggerated this bias, contributing to both the decrease in personal risk estimates and the increase in risk estimates for others. People also may have formed a group identity based on vaccination status. People readily form such identities based on similarity information (Billig & Tajfel, 1973), especially when under threat (Rothgerber, 1997). COVID-19 vaccination was a highly publicized and politicized topic, and the threat of both the disease and perceived uncertainties around the vaccine likely enforced distinctions between vaccinated and unvaccinated individuals (e.g., Blasi, 2021; Ortiz, 2021). In our (supporting) data, a majority of vaccinated participants held negative attitudes toward unvaccinated people (see Table S2) and expressed desires for more relaxed regulations despite perceiving the unvaccinated to be at greater risk of harm.

A clear limitation of the current study is the lack of random assignment to vaccination receipt. To address this, we used multiple techniques to rule out vaccine-irrelevant alternative explanations (see Supporting Material). The current findings are robust against these alternatives: (1) key findings held when controlling for demographics, personality, and local COVID-19 rates, (2) satisfaction with access to, and information regarding, vaccines at time 2 was similar among vaccinated and unvaccinated participants, (3) we ruled out mere time and sampling bias accounts through comparisons with external samples, and (4) analyses with parallel variables on non-disease risks confirmed that vaccination was associated only with altered judgments of COVID-19 risk and not other domains of risk. Using these approaches, we have some confidence that the focal effects presented here arose largely from the vaccination and not from other causes.

Our findings provide a valuable ground for understanding how real-world vaccination against COVID-19 (and potentially other diseases) changes risk perception not only for the self but also for others. Self/other differentiation following vaccination may put unvaccinated others in harm's way when vaccinated decision-makers consider policies applicable to unvaccinated constituents. For instance, vaccinated politicians may make more self-centered decisions by relaxing safety measures, such as isolation or mask mandates, without fully considering the impact on unvaccinated individuals. They may also enforce stringent policies that exclude those who have not been vaccinated (see Bor et al., 2023). Understanding the psychological consequences of vaccination for others as well as for the self thus appears critical to ensuring equitable and inclusive decision-making.

AUTHOR CONTRIBUTIONS

All authors contributed to the hypothesis development, study design, and data collection. Soyeon Choi performed the data analysis and interpretation under the supervision of Joshua M. Ackerman. All authors drafted the manuscript and approved the final version of the manuscript for submission.

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None.

CONFLICT OF INTEREST STATEMENT

We have no known conflict of interest to disclose. Ethics approval was obtained for this work.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Open Science Framework at https://osf.io/7xkn3/.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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