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Implicit and explicit COVID-19-vaccine harmfulness/helpfulness associations predict vaccine beliefs, intentions, and behaviors

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Abstract

We investigated the role of implicit and explicit associations between harm and COVID-19 vaccines using a large sample (N = 4668) of online volunteers. The participants completed a brief implicit association test and explicit measures to evaluate the extent to which they associated COVID-19 vaccines with concepts of *harmfulness* or *helpfulness*. We examined the relationship between these harmfulness/helpfulness COVID-19 vaccine associations and vaccination status, intentions, beliefs, and behavior. We found that stronger implicit and explicit associations that COVID-19 vaccines are helpful relate to vaccination status and beliefs about the COVID-19 vaccine. That is, stronger pro-helpful COVID-19 vaccine associations, both implicitly and explicitly, related to greater intentions to be vaccinated, more positive beliefs about the vaccine, and greater vaccine uptake.

KEYWORDS

decision making, implicit associations, health behavior, vaccine refusal, vaccine hesitancy

While a large body of work has examined explicit beliefs that underly vaccine hesitancy and vaccine refusal, in general (Dubé et al., 2015), far less is known about these implicit vaccine beliefs (Howell et al., 2022). Crucially, no published work that we are aware of has examined the role of associative processes surrounding COVID-19 vaccination. Still, understanding associative processes—that is the process underlying many implicit and explicit beliefs—is important to explaining health behaviors broadly (Sheeran et al., 2016), and when predicting unique variance in vaccination beliefs and behavior specifically (Howell et al., 2022).

When trying to understand the role of associations in beliefs and behaviors, researchers often use both direct measures, like self-report, and implicit measures, like the Implicit Association Test (IAT), which can tap implicit associations that people are either unwilling or unable to report (Gawronski et al., 2020). While people's explicit and implicit associations may be related, they are often independent of one another (Nosek, 2007).

Prior work suggests that having implicit and explicit associations between vaccines and helpfulness (vs. harmfulness) relates to parents' pro-vaccine beliefs and increased likelihood of vaccinating their children (Howell et al., 2022). This work highlights the utility of measuring associations to understand vaccine-related beliefs and behavior. Additionally, this work suggests that the relationship between explicit vaccines-as-helpful associations and vaccine-related beliefs and behaviors can depend on one's implicit vaccines-as-helpful associations—that is, that the two might interact (Howell et al., 2022). In the context of COVID-19, an investigation of associative processes has the potential to explain meaningful variance in vaccination beliefs, intentions, and behavior with direct potential to inform public health interventions. Moreover, a rise in vaccination dishonesty (e.g., about one's vaccination status: Nietzel, 2021) suggests the importance of using both direct and indirect measures to capture a full picture of people's associations (De Houwer, 2006).

In the present research, we investigated implicit and explicit COVID-19-vaccine harmfulness/helpfulness associations using a large sample of online volunteers to examine whether and how associations between COVID-19 vaccines and *harmfulness* or *helpfulness* predicted their beliefs, intentions, and behaviors toward the COVID-19 vaccine. We hypothesized that participants who associated the COVID-19 vaccine with helpfulness would: (a) be more likely to be vaccinated or to intend to become vaccinated; and (b) have more positive beliefs about the COVID-19 vaccine.

1 | METHODS

1.1 | Participants & procedure

Participants were 4668 adult visitors to the Project Implicit Health website who opted to complete the COVID-19-Vaccine task between 17 November 2021 (the date the task was first added) and 24 January 2023 (the date we downloaded data to analyze for this study; see Ratliff & Smith, 2023, for a recent overview of the Project Implicit website). As part of each task on the website, participants complete several measures related to physical health, mental well-being, and demographics. As such, these data represent a portion of a larger, previously unpublished, data set. In this study, we focus primarily on measures that are exclusive to the COVID-19 Vaccine/Harmfulness-Helpfulness task. We selected the specific variables here because we were interested in how implicit and explicit associations and their interaction related to beliefs about and intentions towards the COVID-19 vaccine specifically. A complete list of measures appears at https://osf.io/r7nsz/?view_only=e4f0d1d9eed0407f-93049ca8b95e70ab. Data are available upon request, consistent with our IRB approval.

We restricted analyses to participants who had valid scores on our two primary predictor measures: (a) the COVID-19 Vaccine/Harmfulness-Helpfulness Brief Implicit Association Test (BIAT) and (b) the corresponding explicit attitude measure. Participant demographics and the correlation between demographics and COVID-19-vaccine harmfulness/helpfulness associations appear in Table 1. The majority of the participants in our sample were U.S. residents (80.2%; see Table 1).

TABLE 1 Descriptive statistics for demographics and correlations (r or $r_{point\text{-}biserial}$) between demographics and COVID-19 vaccine harmfulness/helpfulness associations (higher = greater helpfulness).

	M(SD) or %	Explicit	Implicit
Social conservatism (max. 7)	3.2 (1.8)	**−0.48 [−0.50, −0.45]**	**−0.23 [−0.25, −0.20]**
Subjective SES (max. 10)	6.1 (1.6)	**0.13 [0.10, 0.16]**	**0.06 [0.03, 0.09]**
Age	36.0 (14.7)	**0.10 [0.07, 0.13]**	**0.08 [0.05, 0.10]**
US residency	80.2%	**−0.06 [−0.09, −0.03]**	−0.01 [−0.04, 0.02]
Gender			
Male	28.3%	0.02 [−0.01, 0.05]	0.01 [−0.02, 0.04]
Female	69.9%	**−0.03 [−0.06, −0.004]**	−0.02 [−0.05, 0.01]
Non-binary or other	1.7%	0.02 [−0.01, 0.05]	**0.06 [0.03, 0.08]**
Race			
American Indian/Alaska Native	1.9%	−0.02 [−0.05, 0.01]	−0.02 [−0.05, 0.01]
East Asian	5.4%	**0.05 [0.02, 0.08]**	0.03 [−0.004, 0.05]
South Asian	5.5%	**0.07 [0.04, 0.10]**	0.003 [−0.03, 0.03]
Native Hawaiian or other Pacific Islander	1.0%	−0.02 [−0.04, 0.01]	0.01 [−0.02, 0.04]
Black or African American	8.8%	**−0.07 [−0.10, −0.04]**	**−0.04 [−0.07, −0.01]**
White	74.7%	0.01 [−0.02, 0.04]	−0.003 [−0.03, 0.03]
Other or unknown	7.0%	−0.01 [−0.04, 0.02]	−0.001 [−0.03, 0.03]
Hispanic/Latino(a/e/x)	11.1%	**−0.03 [−0.06, −0.01]**	−0.01 [−0.04, 0.02]

Note: **Bolded** estimates indicate $p < 0.001$; $N = 4668$.
Abbreviation: SES, socioeconomic status.

2 | MEASURES

2.1 | Implicit association

A BIAT (Sriram & Greenwald, 2009) measured COVID-vaccine helpfulness/harmfulness associations. We use a BIAT because one can examine implicit associations between a single category—here COVID-19 vaccines—and two attributes—here helpfulness and harmfulness. We adapted the task from Howell et al. (2022) and used the following stimuli: *Helpful* (e.g., Good, Helpful), *Harmful* (e.g., Bad, Harmful), *COVID-19 Vaccine* (e.g., Coronavirus Vaccine, COVID Vaccine), and an unlabeled general category of *Other Medical Behaviors* (e.g., Taking Vitals, Drawing Blood). For a full description of the BIAT, please see https://osf.io/r7nsz/?view_only=e4f0d1d9eed0407f93049ca8b95e70ab.

Participants were assigned an implicit *D* score (Nosek et al., 2014) which compared mean reaction time differences between the two types of blocks. *D* scores ranged from −1.09–1.49, where a score of −0.15 to +0.15 represented equal/neutral implicit association between the COVID-19 vaccine and both helpfulness/harmfulness ($M = 0.20$, SD = 0.35) (Sriram & Greenwald, 2009).[1]

2.2 | Explicit association

Participants responded to a single item indicating their explicit association: "To what extent do you think the COVID-19 vaccine is helpful versus harmful" (1 = *very harmful*, 7 = *very helpful*; $M = 5.73$, SD = 1.72), which matched the comparative construct we were trying to tap with the BIAT.

2.3 | COVID-19 vaccination status

Participants responded to the statement, "Have you had at least one dose of one of the COVID-19 vaccine?" on a 5-point scale (1 = *yes*, 2 = *no, but I will get it when I am allowed to/when it is my turn*, 3 = *no, I am waiting to see what happens with others before I consider getting the vaccine*, 4 = *no, and I do not plan to*, 5 = *unsure/other*). For analyses, COVID-19 vaccination status was recoded, 1 as "Yes" (86.4%) 2–4 as "No" (11.0%).

2.4 | COVID-19 vaccine intentions (unvaccinated participants only)

Participants who had not yet been vaccinated (n = 524) responded to the statement, "Do you intend to get the COVID-19 vaccine (if it is not currently available to you, once it is available to you)?" using a 3-point scale (1 = *yes*, 2 = *no*, 3 = *unsure/other*). Analyses focused on those who answered yes (5.7%) or no (83.2%).

2.5 | COVID-19 booster intentions (vaccinated participants only)

Participants who received a vaccine (n = 4029) indicated whether they would get (another) booster shot "Would you get the COVID-19 vaccine again if you were told to renew your vaccination (e.g., to get a booster shot)?" using a 3-point scale (1 = *yes*, 2 = *no*, 3 = *unsure/other*). Analyses focused on those who answered "yes" (coded as 1; 77.5%) or "no" (coded as 0; 11.5%).

2.6 | COVID-19 vaccine beliefs

Participants indicated their endorsement of several beliefs on a 1 = *strongly disagree*, 7 = *strongly agree scale* (adapted from Freed et al., 2010).

Perceived protective benefit. "Getting the COVID-19 vaccine is a good way to protect myself from being harmed by COVID-19" (M = 5.48, SD = 1.94).

Comparative safety. "The COVID-19 vaccine is as safe as other vaccines" (M = 5.00, SD = 1.95).

Concerns about adverse effects. "I am concerned about short term negative effects of the COVID-19 vaccine" and "I am concerned about long term negative effects of the COVID-19 vaccine." We took the average of these items to create a single index of concerns about adverse effects, $r(4539) = 0.64$ $CI_{95\%=}[0.62, 0.66]$ (M = 3.64, SD = 1.87).

Vaccine research perceptions. "There has not been enough research on the COVID-19 vaccine" (M = 3.85, SD = 2.08).

2.7 | Analyses

Using IBM SPSS v.29, we conducted regressions using participants' (grand-mean centered) implicit associations, (grand-mean centered) explicit associations, and their interaction to predict COVID-19 vaccination status, intentions, and beliefs. In a second set of regressions, we controlled for demographics to ensure our effects were not an artifact of demographics. Because of the categorical nature of race and gender, we entered them as contrast codes. For gender, we had two codes: Contrast code 1 compared men—the gender with the greatest structural power—to both women and those who identified as non-binary/other. Contrast 2 compared women to those who identified as non-binary/other. For race, we had three contrast codes. Contrast 1 compared White people—the race with the greatest structural power—to all other groups. Contrast 2 compared Asian people to other Black, Indigenous, and

People of Color (BIPOC) individuals. Prior research has shown that Asian people vaccinated themselves at higher rates than other BIPOC groups (Nguyen et al., 2021; Tai et al., 2021). Contrast 3 compared Black people—the largest remaining BIPOC group—to all non-Asian BIPOC people. We did not conduct any additional contrasts given the small size of the remaining groups and the atheoretical nature of the comparisons. Of note, these contrasts were not of primary interest but are provided for transparency and completeness.

When there was a significant interaction between implicit and explicit associations, we examined the simple main effects of explicit associations at low (−1 SD; $d_{iat} = -0.15$) and high (implicit associations at +1 SD; $d_{iat} \sim 0.55$) levels of implicit associations (Sriram & Greenwald, 2009).

3 | RESULTS

Participants generally associated the vaccine with helpfulness both explicitly ($M = 5.73$, SD = 1.72) and implicitly ($M = 0.20$, SD = 0.35). For explicit associations, those who were older, Asian, and higher in subjective-socioeconomic status were more likely to associate the COVID-19 vaccine with helpfulness, whereas women, those higher in social conservatism, Black/African-American, US residents, and Hispanic/Latino(a/x/e) were more likely to associate the COVID-19 vaccine with harmfulness (see Table 1). For implicit associations, people who were older, nonbinary, and higher in subjective-socioeconomic status were more likely to associate the COVID-19 vaccine with helpfulness, whereas those higher in social conservatism, and Black/African-American were more likely to associate the COVID-19 vaccine with harmfulness (see Table 1).

3.1 | COVID-19 vaccination status & intentions

As Table 2 shows, both stronger implicit and explicit COVID-vaccine-helpfulness associations predicted greater odds of being vaccinated and having intentions to get a booster. Explicit, but not implicit, COVID-vaccine-helpfulness associations predicted greater intentions to get one's first vaccine. These main effects were not qualified by an interaction between implicit and explicit and persisted even when controlling for demographic factors.

3.2 | COVID-19 vaccine beliefs

As Table 3 shows, both increased implicit and explicit COVID-vaccine-helpfulness associations predicted increased belief that the vaccines would be effective in preventing harm from COVID-19, increased sense that the COVID-19 vaccine was as safe as other vaccines, decreased expectations of adverse effects, and decreased feelings that research into the COVID-19 vaccine was lacking. These main effects were qualified by interactions on three of the variables: perceptions of vaccine effectiveness in preventing harm from COVID-19, expectation of adverse effects, and feelings that research into the COVID-19 vaccine was lacking. As the middle two rows of estimates in Table 3 show, people's explicit associations explained more variance in perceptions of prevention effectiveness when implicit associations were lower (-1SD) than when implicit associations were high (+1SD). By contrast, people's explicit associations explained more variance in both (a) expectation of adverse effects and (b) feelings about research into the vaccine when implicit associations were high (+1SD) than when they were low (-1SD). These effects persisted when controlling for demographic factors with one exception: the interaction was no longer significant in predicting expectations of adverse effects (see https://osf.io/r7nsz/?view_only=e4f0d1d9eed0407f93049ca8b95e70ab for fig. 2).

4 | DISCUSSION

The present study examined peoples' implicit and explicit associations between the COVID-19 vaccine and helpfulness/harmfulness. On average, participants associated the vaccine with *helpfulness* (vs. *harmfulness*). Stronger

TABLE 2 Results from logistic regressions.

		Vaccine intentions	
	Vaccine status (all participants)	First vaccine (unvaccinated only)	(Next) booster (vaccinated only)
Model 1		OR [$CI_{95\%}$]	
Explicit associations	2.59 [2.40, 2.79]**	2.42 [1.76, 3.33]**	3.22 [2.93, 3.55]**
Implicit associations	3.42 [1.95, 5.97]**	0.79 [0.13, 4.76]	2.76 [1.81, 4.21]**
Imp. x exp.	1.11 [0.91, 1.35]	0.58 [0.23, 1.50]	1.00 [0.75, 1.34]
Model 2			
Explicit associations	2.38 [2.18, 2.59]**	2.86 [1.86, 4.41]**	2.82 [2.55, 3.12]**
Implicit associations	2.76 [1.47, 5.17]*	0.83 [0.10, 6.66]	2.69 [1.69, 4.29]**
Imp. x exp.	1.03 [0.83, 1.29]	0.64 [0.23, 1.78]	0.95 [0.70, 1.29]
Conservatism	0.72 [0.66, 0.78]**	0.65 [0.45, 0.94]*	0.67 [0.61, 0.73]**
Subjective SES	1.08 [1.00, 1.18]	0.81 [0.59, 1.10]	0.99 [0.91, 1.08]
Age	1.35 [1.21, 1.50]**	1.53 [0.98, 2.41]	1.19 [1.07, 1.32]**
Race contrast 1	0.83 [0.59, 1.17]	0.25 [0.08, 0.81]*	0.82 [0.59, 1.14]
Race contrast 2	3.36 [1.62, 6.97]*	2.57 [0.22, 30.17]	3.11 [1.68, 5.76]**
Race contrast 3	0.60 [0.32, 1.13]	1.01 [0.16, 6.55]	0.37 [0.18, 0.73]*
Gender contrast 1	1.75 [0.96, 3.19]	2.37 [0.44, 12.77]	1.01 [0.42, 2.45]
Gender contrast 2	0.32 [0.11, 0.97]*	0.57 [0.03, 11.53]	1.20 [0.22, 6.49]
US Resident	1.10 [0.74, 1.63]	0.49 [0.11, 2.15]	1.32 [0.91, 1.91]
Hispanic	0.72 [0.49, 1.07]	1.33 [0.40, 4.42]	0.99 [0.64, 1.55]

Note: * = $p < 0.05$, ** = $p < 0.001$.

Abbreviation: SES, socioeconomic status.

associations between COVID-19 vaccines and helpfulness—both implicitly and explicitly—related to more positive beliefs about the vaccine, greater intentions to be vaccinated, and greater vaccine uptake. This evidence adds to a growing body of research suggesting associative processes in vaccine beliefs, intentions, and behaviors (e.g., Howell et al., 2022) and is the first to suggest that both implicit and explicit associations relate to COVID-19 vaccine beliefs and intentions. Additionally, these findings suggest that researchers interested in understanding the cognitive underpinnings of vaccine-related decision-making and behavior should consider using both direct and indirect measurement approaches in trying to capture cognitions, in particular when trying to understand beliefs, intentions, and uptake toward new vaccines.

Limitations of this study offer opportunities for future research. First, this study collected data from the Project-Implicit-Health website, which limits generalizability—people are volunteers and self-selected to take this IAT. Future work that recruits specific sub-populations that might not select this task, like self-identified anti-vaxxers, might reveal different relationships than reported here. Second, this study did not examine any longitudinal or temporal trends in the data. Certainly, a more nuanced temporal understanding of this data, linked to population trends in vaccine mandates, changes in government-approval status, and overall vaccination rates, is warranted.

Overall, the present study provides initial insight into the role of implicit and explicit associations and COVID-19 vaccine beliefs, intentions, and behaviors. The results add to an emerging literature on how helpful/harmful vaccine implicit and explicit associations relate to vaccine behavior and beliefs. Further investigation is needed to more fully understand how associations towards vaccines may change over time, but this work represents a first step in understanding how associations might inform pandemic vaccination behavior.

TABLE 3 Results from linear regressions.

	Protective benefit	Safety	Adverse effects	Research perceptions
			b [$CI_{95\%}$]	
Model 1				
Explicit	0.83 [0.81, 0.86]**	0.82 [0.79, 0.84]**	−0.62 [−0.64, −0.59]**	−0.72 [−0.75, −0.69]**
Implicit	0.34 [0.23, 0.45]**	0.48 [0.37, 0.60]**	−0.46 [−0.60, −0.33]**	−0.50 [−0.65, −0.35]**
Exp. x Imp.	−0.07 [−0.13, −0.02]*	0.04 [−0.02, 0.10]	−0.09 [−0.16, −0.02]*	−0.20 [−.28, −0.13]**
Effect of explicit at...				
1 SD implicit	**0.86 [0.83, 0.88]**	–	**−0.58 [−0.61, −0.55]**	**−0.65 [−0.69, −0.62]**
+1 SD implicit	**0.81 [0.77, 0.84]**	–	**−0.65 [−0.69, −0.60]**	**−0.79 [−0.84, −0.74]**
Model 2				
Explicit	0.76 [0.73, 0.79]**	0.72 [0.70, 0.75]**	−0.54 [−0.57, −0.50]**	−0.61 [−0.65, −0.58]**
Implicit	0.29 [0.18, 0.40]**	0.43 [0.31, 0.54]**	−0.39 [−0.52, −0.25]**	−0.43 [−0.58, −0.28]**
Imp. x exp.	−0.09 [−0.15, −0.04]*	0.01 [−0.05, 0.07]	−0.07 [−0.14, 0.00]*	−0.17 [−0.24, −0.09]**
Conservatism	−0.13 [−0.16, −0.11]**	−0.18 [−0.21, −0.16]**	0.17 [.14, 0.20]**	0.23 [0.20, 0.26]**
Subjective SES	0.04 [0.02, 0.06]*	0.04 [0.01, 0.06]*	−0.07 [−0.10, −0.04]**	−0.07 [−0.10, −0.04]**
Age	−0.01 [−0.04, 0.01]	0.01 [−0.02, 0.03]	0.04 [0.01, 0.07]*	0.04 [0.00, 0.07]*
Race contrast 1	−0.02 [−0.10, 0.07]	0.10 [0.01, 0.19]*	−0.37 [−0.48, −0.27]**	−0.28 [−0.39, −0.16]**
Race contrast 2	0.43 [0.27, 0.58]**	0.10 [−0.07, 0.26]	0.00 [−0.20, 0.19]	0.12 [−0.09, 0.33]
Race contrast 3	−0.09 [−0.28, 0.11]	−0.12 [−0.33, 0.09]	0.17 [−0.07, 0.41]	0.01 [−0.25, 0.28]
Gender contrast 1	0.26 [0.11, 0.42]**	0.11 [−0.05, 0.27]	−0.26 [−0.45, −0.07]*	−0.17 [−0.38, 0.04]
Gender contrast 2	−0.39 [−0.67, −0.12]*	0.06 [−0.23, 0.35]	−0.11 [−0.45, 0.23]	0.00 [−0.38, 0.37]
US Resident	0.09 [−0.01, 0.19]	0.08 [−0.02, 0.18]	−0.14 [−0.26, −0.03]*	−0.09 [−0.22, 0.04]
Hispanic	−0.06 [−0.19, 0.06]	−0.15 [−0.28, −0.03]*	0.13 [−0.02, 0.28]	0.08 [−0.09, 0.24]

Note: * = $p < 0.05$, ** = $p < 0.001$. Bolded estimates indicate $p < 0.05$.

Abbreviation: SES, socioeconomic status.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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ENDNOTE

[1] Unfortunately, due to a coding error, we do not have trial-by-trial data for the IAT. IAT scores were calculated directly by the Project Implicit system itself (see https://minnojs.github.io/docs/time/api/scorer/ for documentation). The system implements the following rules during scoring: Trials with latencies under 400 ms are not included, trials with latencies over 2000 ms are not included, when participants make errors a 600 ms penalty is imposed to their response, anyone who has more than 10% of trials faster than 150 ms is considered to be responding too quickly, and thus does not receive a IAT score.

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Bethany A. Teachman. Bethany Teachman is a Professor, and the Director of Clinical Training and the Director of Diversity and Inclusion at the University of Virginia in the Department of Psychology. She received her Ph.D. from Yale University, and her BA from the University of British Columbia. Her lab investigates biases in cognitive processing that contribute to the development and maintenance of psychopathology, especially anxiety disorders.

Alexandra Werntz. Alexandra Werntz is the current Associate Director of the Center for Evidence-Based Mentoring at the University of Massachusetts Boston and a clinical psychologist/therapist with Virginia Family Therapy. She received her MA and Ph.D. with a focus on Clinical Psychology from the University of Virginia.

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