

# Communications to Promote Interest and Confidence in COVID-19 Vaccines

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## Abstract

**Purpose:** Communicating about COVID-19 vaccine side effects and efficacy is crucial for promoting transparency and informed decision-making, but there is limited evidence on how to do so effectively.

**Design:** A within-subjects experiment.

**Setting:** Online survey from January 21 to February 6, 2021.

**Subjects:** 596 US Veterans and 447 non-Veterans.

**Intervention:** 5 messages about COVID-19 vaccine side effects and 4 messages about COVID-19 vaccine efficacy.

**Measures:** COVID-19 vaccine interest (1 = “I definitely do NOT want the vaccine” to 7 = “I definitely WANT the vaccine” with the midpoint 4 = “Unsure”). Confidence about COVID-19 vaccine efficacy (1 = “Not at all confident,” 2 = “Slightly confident,” 3 = “Somewhat confident,” 4 = “Moderately confident,” 5 = “Extremely confident”).

**Results:** Compared to providing information about side effects alone ( $M = 5.62 [1.87]$ ), messages with additional information on the benefits of vaccination ( $M = 5.77 [1.82]$ ,  $P < .001$ ,  $d_z = .25$ ), reframing the likelihood of side effects ( $M = 5.74 [1.84]$ ,  $P < .001$ ,  $d_z = .23$ ), and emphasizing that post-vaccine symptoms indicate the vaccine is working ( $M = 5.72 [1.84]$ ,  $P < .001$ ,  $d_z = .17$ ) increased vaccine interest. Compared to a vaccine efficacy message containing verbal uncertainty and an efficacy range ( $M = 3.97 [1.25]$ ), messages conveying verbal certainty with an efficacy range ( $M = 4.00 [1.24]$ ,  $P = .042$ ,  $d_z = .08$ ), verbal uncertainty focused on the upper efficacy limit ( $M = 4.03 [1.26]$ ,  $P < .001$ ,  $d_z = .13$ ), and communicating the point estimate with certainty ( $M = 4.02 [1.25]$ ,  $P < .001$ ,  $d_z = .11$ ) increased confidence. Overall, Veteran respondents were more interested ( $M_{Veterans} = 5.87 [1.72]$  vs  $M_{NonVeterans} = 5.45 [2.00]$ ,  $P < .001$ ,  $d = .22$ ) and confident ( $M_{Veterans} = 4.13 [1.19]$  vs  $M_{NonVeterans} = 3.84 [1.32]$ ,  $P < .001$ ,  $d = .23$ ) about COVID-19 vaccines than non-Veterans.

**Conclusions:** These strategies can be implemented in large-scale communications (e.g., webpages, social media, and leaflets/posters) and can help guide healthcare professionals when discussing vaccinations in clinics to promote interest and confidence in COVID-19 vaccines.

## Keywords

health communications, COVID-19 vaccine, interventions, health policy, vaccine hesitancy

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Following the swift development and widespread distribution of multiple COVID-19 vaccines, focus has shifted toward ensuring sufficient vaccine uptake. One of the most consistent findings from surveys of the US public conducted throughout the pandemic is that many people are hesitant about receiving a COVID-19 vaccine.<sup>1,2</sup> While multiple factors contribute to vaccine hesitancy,<sup>3</sup> there is consistent evidence that concerns about perceived risks (e.g., side effects) and benefits (e.g., perceptions about vaccine efficacy) are particularly important factors.<sup>4-6</sup>

Worries about vaccine safety and side effects have been shown to be a critical factor for vaccine acceptance across a range of different vaccines and populations.<sup>4,7,8</sup> Aligned with this prior research, many people who are hesitant or outright opposed to getting a COVID-19 vaccine report concerns about their general safety and possible side effects.<sup>9</sup> Common, but discomforting, side effects from the COVID-19 vaccines are an unfortunate, but not unexpected outcome of mass-vaccination programs.<sup>10</sup> Transparent reporting of possible side effects from vaccines is crucial for people to make informed decisions about their health as well as increasing public confidence and trust.<sup>11</sup> However, one challenge for health communicators reporting this information is that exposure to reports about side effects might raise concerns about vaccine safety and, in turn, increase vaccine hesitancy.<sup>1,12,13</sup>

Research from other medical contexts has identified potential strategies for communicating about side effects in ways which may help to avoid potential negative outcomes and might also promote interest in the vaccines. For example, communications explaining that side effects can indicate the medication is working,<sup>14</sup> highlighting the benefits of the medication,<sup>15,16</sup> focusing on the possibility of not experiencing the side effects,<sup>17,18</sup> and messages from friends and family on social media<sup>19,20</sup> can have positive impacts on attitudes and experiences of potential side effects. Some of these communication strategies were quickly adopted by health organizations in their materials and resources about COVID-19 vaccine side effects.<sup>21,22</sup> However, whether these strategies are effective in the context of the COVID-19 vaccines has been understudied and as a consequence remains poorly understood. Identifying which strategies may be most effective for transparently communicating about possible side effects from the COVID-19 vaccines in order to avoid negative outcomes (e.g., increased safety concerns and hesitancy) and to promote interest in getting vaccinated therefore represents an important target for research with considerable implications for public health.

In addition to concerns about vaccine safety and possible side effects, research on vaccine hesitancy has demonstrated that acceptance of a vaccine also depends greatly on how confident people are about its efficacy.<sup>4,23</sup> Indeed, doubts about the efficacy and general benefit of the COVID-19 vaccines have been cited as reasons for COVID-19 vaccine hesitancy and refusal.<sup>24</sup> All of the currently authorized COVID-19 vaccines have demonstrated high efficacy against COVID-19<sup>25</sup> and this has been reflected in widespread

positive media coverage.<sup>26</sup> However, variations in the style of reporting about the efficacy of COVID-19 vaccines may reflect insufficient knowledge about how best to present this information.<sup>27</sup> For instance, many reports ignore uncertainty, presenting only point estimates without any verbal quantifiers (e.g., “the vaccine is 95% effective”).<sup>26</sup> While other reports have acknowledged uncertainty either with verbal probability terms (e.g., “the vaccine *is likely* to be effective”), by referring to intervals around estimates (e.g., “the vaccine is between 90-98% effective”), or with some combination of the two.<sup>28,29</sup>

Although acknowledging uncertainty and promoting transparency are key principals of good, ethical health communication, communicators may be tempted to avoid doing so out of fear that it may result in reduced trust, perceived incompetence, lower confidence, and, in turn, greater hesitancy toward vaccines.<sup>30,31</sup> However, recent evidence has demonstrated that it is possible to communicate uncertainty about public health threats as well as about facts and numbers in general whilst avoiding potentially negative outcomes.<sup>31,32</sup> Moreover, this approach may be preferred by receivers when communicating information about the COVID-19 pandemic.<sup>33</sup> Thus, there is a need for better understanding of how different methods for communicating about vaccine efficacy influences confidence in vaccines in order to help inform reporting choices by scientists and journalists.<sup>34,35</sup>

Effective communication about possible side effects and efficacy of COVID-19 vaccines can contribute to ending the pandemic by reducing hesitancy and increasing confidence in vaccines. The objectives of this study were to (1) determine the effectiveness of different methods of presenting information about the side effects from a COVID-19 vaccine on vaccine interest and (2) test the impact of different messages of varying uncertainty about the efficacy of a COVID-19 vaccine on vaccine confidence.

## Methods

**Sample.** Respondents were recruited by Qualtrics Online Panels between January 21 and February 6, 2021 for the second survey of a longitudinal study about the experiences of US Veterans and non-Veterans during the pandemic. A total of 2085 respondents ( $n_{\text{Veteran}}=1060$ ;  $n_{\text{nonVeteran}}=1025$ ) completed the first survey in December 2020 all of whom were re-contacted and invited to take part in the second survey. Prior to beginning the survey, respondents read a consent letter which explained that consent was implied by completion of the survey. Respondents were compensated \$6.00 for their participation in the survey. A total of 1257 respondents completed the second survey (completion rate: 60% overall, 70% for Veteran respondents, and 50% for non-Veteran respondents). The median age of the sample was between 55 and 74 years old; 957 respondents (76%) were male, 965 respondents (77%) were non-Hispanic White, and 746 respondents (59%) were Veterans (Table 1). The median household income among respondents

**Table 1.** Respondent Demographics Overall and Split by Veteran and Non-Veteran Respondents.

	Overall	Veteran N (%)	Non-Veteran
<i>Age</i>			
18 to 34	68 (5)	0 (0)	68 (13)
35 to 54	142 (11)	22 (3)	120 (24)
55 to 74	773 (61)	497 (67)	276 (54)
75 or older	271 (22)	225 (30)	46 (9)
Did not respond	3 (<1)	2 (<1)	1 (<1)
<i>Gender</i>			
Female	297 (24)	48 (6)	249 (49)
Male	957 (76)	697 (94)	260 (51)
Non-binary/third gender or transgender man/transman	3 (<1)	1 (<1)	2 (<1)
<i>Race/Ethnicity</i>			
Non-Hispanic White	967 (77)	571 (76)	396 (77)
Non-Hispanic Black	102 (8)	62 (8)	40 (8)
Hispanic	114 (9)	73 (10)	41 (8)
Asian/Asian American	37 (3)	13 (2)	24 (5)
American Indian/Alaskan Native	4 (<1)	4 (<1)	0 (0)
Native Hawaiian/Other Pacific Islander	3 (<1)	3 (<1)	0 (0)
Another race	17 (1)	13 (2)	4 (1)
Multiracial	11 (1)	7 (1)	4 (1)
Did not respond	2 (<1)	0 (0)	2 (<1)
<i>Income</i>			
\$0–\$49,000	301 (24)	164 (22)	137 (27)
\$50,000 to \$99,000	463 (37)	285 (38)	178 (35)
\$100,000 or more	431 (34)	265 (36)	166 (33)
Prefer not to say	62 (5)	32 (4)	30 (6)
<i>Residence</i>			
Rural	205 (16)	121 (16)	84 (16)
Small (less than 100,000)	222 (18)	142 (19)	80 (16)
Suburban near large city	598 (48)	349 (47)	249 (49)
Mid-sized city (100,000 to 1 million)	114 (9)	68 (9)	46 (9)
large city (more than 1 million)	113 (9)	62 (8)	51 (10)
Other	4 (<1)	4 (1)	0 (0)
Did not respond	1 (<1)	0 (0)	1 (<1)

was \$50,000–\$99,999 and most respondents reported that they had not received a COVID-19 vaccine (1,043, 83%).

**Design and measures.** This IRB-approved study was administered online (in English) and is compliant with AA-POR guidelines. Initially, respondents answered questions about their current behaviors, their well-being and healthcare experiences, and their attitudes/perceptions regarding the COVID-19 pandemic, before seeing materials for the present experiment. The present experiment used a within-subjects design. Respondents first saw 5 different messages (Baseline, positive pain, benefit frame, reframing likelihood, and social media) about common side effects associated with COVID-19 vaccination (see Table 2 for messages). The baseline message was designed to portray the possible side effects as succinctly and accurately as possible, whereas the positive pain message was designed to reflect the messaging by public health

organizations that side effects indicate the vaccine is working.<sup>14,21,22</sup> The benefit frame (i.e., focusing on the personal benefits of vaccination),<sup>15,16</sup> reframing likelihood (i.e., focusing on the possibility of not experiencing side effects),<sup>17,18</sup> and social media (i.e., a message from a trusted friend)<sup>19,20</sup> messages were designed based on prior research on messaging about side effects and vaccines. The baseline message was presented first with the subsequent 4 messages presented in random order. Respondents indicated how interested they felt about getting the COVID-19 vaccine after reading each message using a 7-point scale ranging from 1 (I definitely do NOT want the vaccine) to 7 (I definitely WANT the vaccine) with 4 (Unsure) as the scale midpoint.

Respondents then saw 4 different messages (Full uncertainty, efficacy range, upper limit, and no uncertainty) about the efficacy associated with COVID-19 vaccination (Table 2).

**Table 2.** Messages Regarding Side Effects of COVID-19 Vaccine and Vaccine Effectiveness.

<b>Messages About COVID-19 Vaccine Side Effects</b>
<p><b>Baseline</b> The COVID-19 vaccines may have some uncomfortable side effects such as fever and muscle pain which only last for a short time (e.g., a day)</p> <p><b>Positive pain</b> The COVID-19 vaccines may have some uncomfortable side effects such as fever and muscle pain which only last for a short time (e.g., a day). These side effects are a sign that the vaccine is working to help protect you against COVID-19</p> <p><b>Benefit frame</b> Getting the COVID-19 vaccine is proven to be beneficial—it decreases your risk of getting sick from COVID-19 by 95% after taking both shots. It will protect you and those closest to you, even if you may have some uncomfortable side effects such as fever and muscle pain which last for a short time (e.g., a day)</p> <p><b>Reframing likelihood</b> The COVID-19 vaccines may have some uncomfortable side effects such as fever and muscle pain which only last for a short time (e.g., a day). However, many people do not get any side effects after getting the vaccine</p> <p><b>Social media</b> A social media post (e.g., Facebook AND Twitter) from a trusted friend who says: “I got my COVID-19 vaccine! My arm is a bit sore and I have a slight fever—but am SO glad I am protecting myself from COVID-19!”</p>
<b>Messages about COVID-19 vaccine efficacy</b>
<p><b>Full uncertainty (Verbal uncertainty with efficacy range)</b> Available data confirms that the vaccine is most likely between 90% and 98% effective in preventing COVID-19</p> <p><b>Efficacy range (Verbal certainty with efficacy range)</b> Available data confirms that the vaccine is between 90% and 98% effective in preventing COVID-19</p> <p><b>Upper limit (Verbal uncertainty with upper efficacy limit)</b> Available data confirms that the vaccine may be as high as 98% effective in preventing COVID-19</p> <p><b>No uncertainty (Verbal certainty with point estimate)</b> Available data confirms that the vaccine is 95% effective in preventing COVID-19</p>

The messages about vaccine efficacy were designed to reflect how the COVID-19 vaccine trial results have been reported<sup>26,36,37</sup> and to acknowledge the uncertainty in the trial results as published by the vaccine manufacturers and the U.S Food and Drug Administration.<sup>38,39</sup> These messages were presented in random order and, for each message, respondents indicated how confident the message made them feel about the effectiveness of the vaccine on a 5-point scale (1 = “Not at all confident,” 2 = “Slightly confident,” 3 = “Somewhat confident,” 4 = “Moderately confident,” 5 = “Extremely confident”).

**Analysis.** All analyses were performed using RStudio Version 1.4.1106 and were conducted in 2021.<sup>40</sup> We used linear mixed models analyses to examine 1) the effects of the messages about side effects on COVID-19 vaccine interest and 2) the effects of the messages about vaccine efficacy on confidence in the vaccine. We constructed 2 separate models, each with fixed effects for messages (for the 5 side effect messages or 4 uncertainty messages) and Veteran status (Veteran or not) and random intercepts for each respondent. Separate models were conducted to account for respondents reported age, gender, income, and race/ethnicity.

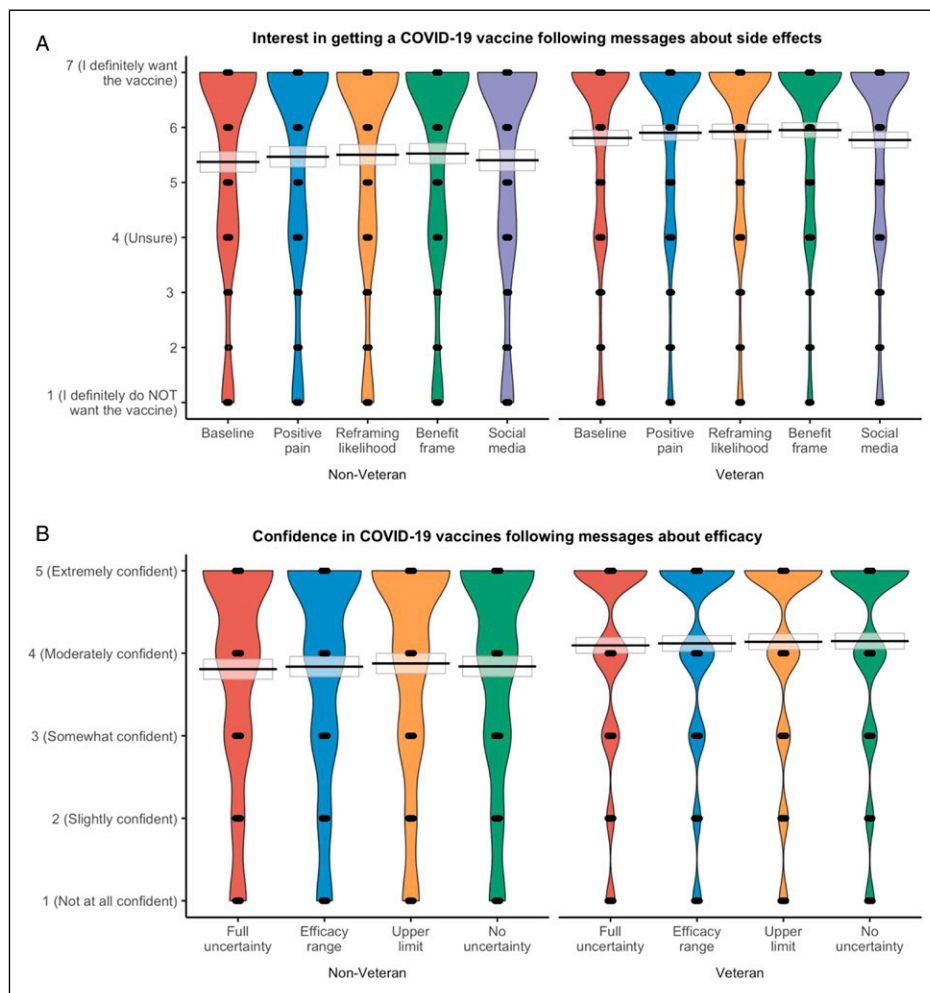
For models with a significant main effect of message (two-tailed significance level for  $\alpha = .05$ ), we conducted pairwise comparisons (adjusting for multiple comparisons using

Bonferroni correction) and conducted independent *t*-tests for significant main effects of Veteran status.

## Results

*Messages about vaccine side effects:* Overall, respondents' interest in getting a COVID-19 vaccine was high ( $M = 5.69$ ,  $SD = 1.86$ ; scale maximum = 7). We found that vaccine interest varied significantly across the different messages about possible side effects,  $F(4,4158) = 27.71$ ,  $P < .001$ ,  $\eta_p^2 = .026$ , and according to respondents' Veteran status,  $F(1,1040) = 13.61$ ,  $P < .001$ ,  $\eta_p^2 = .003$ , but found no significant interaction between the two,  $F(4,4158) = 1.12$ ,  $P = .344$ ,  $\eta_p^2 = .001$ , (Figure 1; Panel A).

Pairwise comparisons revealed that compared to the baseline ( $M = 5.62$  [1.87]) and social media messages ( $M = 5.61$  [1.92]), the messages emphasizing that post-vaccine symptoms are a good sign the vaccine is working (Positive pain;  $M = 5.72$  [1.84],  $P < .001$ ,  $d_z = .17$  and  $P < .001$ ,  $d_z = .15$ , respectively), communicating the likelihood of not experiencing side effects from the vaccine (Reframing likelihood;  $M = 5.74$  [1.84],  $P < .001$ ,  $d_z = .23$  and  $P < .001$ ,  $d_z = .19$ , respectively), and highlighting the benefits of vaccination (Benefit frame;  $M = 5.77$  [1.82],  $P < .001$ ,  $d_z = .25$  and  $P < .001$ ,  $d_z = .22$ , respectively) all significantly increased respondents' interest in getting a COVID-19 vaccine. Additionally,



**Figure 1.** Results shown in separate panels for respondents' interest (Panel A) and confidence (Panel B) toward COVID-19 vaccines and split between Veteran and non-Veteran respondents. The middle bold line represents the mean, and the box borders represent 95% confidence intervals. Individual data points are displayed with shaded density distributions.

the Benefit frame message also significantly increased vaccination interest compared to the Positive pain message ( $P = .004$ ,  $d_z = .11$ ). None of the other comparisons significantly impacted vaccine interest ( $ps > .470$ ).

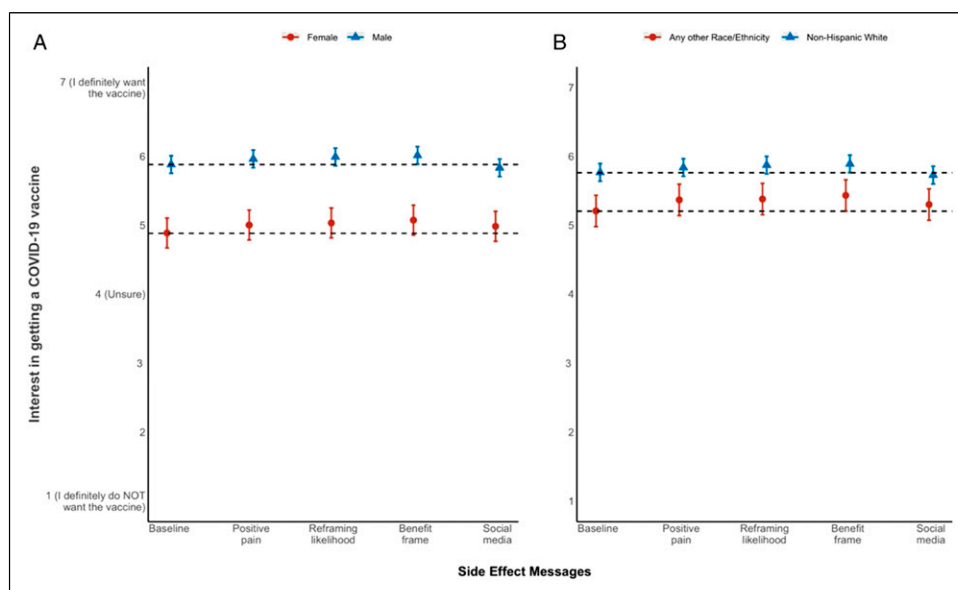
Vaccine interest was significantly higher for Veteran respondents ( $M = 5.87$ ,  $SD = 1.72$ ) as compared to non-Veteran respondents ( $M = 5.45$ ,  $SD = 2.00$ );  $t(4376.46) = 7.90$ ,  $P < .001$ ,  $d = .22$ . Vaccine interest was also higher for respondents who were older, Male, non-Hispanic White, and with higher reported annual income (see Table 3). We found evidence of an interaction between the side effect messages and both respondents' gender ( $F(4,4146) = 3.30$ ,  $P = .010$ ,  $\eta_p^2 = .003$ ) and race ( $F(4,4150) = 2.56$ ,  $P = .037$ ,  $\eta_p^2 = .002$ ). The interaction (Figure 2) showed that compared to the baseline message the social media message had a negative impact on confidence for those with higher vaccine confidence (i.e., Male respondents and non-Hispanic White respondents), but a positive impact for those with lower vaccine confidence (i.e., Female respondents and any other race).

*Messages about vaccine efficacy:* Overall, respondents were mostly confident about the effectiveness of vaccines ( $M = 4.00$ ,  $SD = 1.25$ ; scale maximum = 5). We found that confidence in the effectiveness of the vaccines varied significantly across the different uncertainty messages,  $F(3,3118) = 8.30$ ,  $P < .001$ ,  $\eta_p^2 = .008$ , and according to respondents' Veteran status,  $F(1,1040) = 13.87$ ,  $P < .001$ ,  $\eta_p^2 = .004$ , but found no significant interaction between the two,  $F(3,3118) = 1.18$ ,  $P = .315$ ,  $\eta_p^2 = .001$ , (Figure 1; Panel B).

Pairwise comparisons revealed that the messages that presented the vaccine efficacy range without any verbal probability terms (Efficacy range;  $M = 4.00$  [1.24],  $P = .042$ ,  $d_z = .08$ ), that contained verbal uncertainty focused on the upper efficacy limit (Upper limit;  $M = 4.03$  [1.26],  $P < .001$ ,  $d_z = .13$ ), and that stated the point estimate with certainty (No uncertainty;  $M = 4.02$  [1.25],  $P < .001$ ,  $d_z = .11$ ) all significantly increased confidence in the effectiveness of COVID-19 vaccines compared to the full uncertainty message with both verbal probability terms and confidence intervals ( $M = 3.97$

**Table 3.** Respondents' vaccine interest and confidence across the different messages with models accounting for reported age, gender, income, and Race/Ethnicity.

	Vaccine interest (1–7 scale)	Vaccine confidence (1–5 scale)	Side effect messages (Vaccine interest)				Vaccine efficacy messages (Vaccine confidence)				
	M (SD)		DF	F	p	$\eta_p^2$	DF	F	p	$\eta_p^2$	
<b>Age</b>											
18 to 34	4.37 (2.34)	3.21 (1.47)									
35 to 54	5.15 (1.97)	3.68 (1.31)	Effect of messages:	4,4142	11.75	<.001	.011	3,3106	5.97	<.001	.006
55 to 74	5.79 (1.79)	4.03 (1.24)	Effect of age:	3,1036	21.33	<.001	.015	3,1036	19.19	<.001	.018
75 or older	6.19 (1.52)	4.40 (.95)	Interaction:	12,4142	1.57	.094	.005	9,3106	1.63	.100	.005
<b>Gender</b>			Effect of messages:	4,4146	20.37	<.001	.019	3,3109	6.341	<.001	.006
Female	4.99 (2.29)	3.54 (1.49)	Effect of gender:	1,1037	55.84	<.001	.013	1,1037	55.08	<.001	.017
Male	5.93 (1.62)	4.17 (1.11)	Interaction:	4,4146	3.30	.010	.003	3,3109	1.31	.271	.001
<b>Income</b>			Effect of messages:	4,3946	25.84	<.001	.025	3,2959	8.56	<.001	.009
\$0–\$49,000	4.96 (2.10)	3.53 (1.41)	Effect of income:	2,987	41.26	<.001	.020	2,987	36.65	<.001	.024
\$50,000 to \$99,000	5.83 (1.78)	4.12 (1.16)	Interaction:	8,3946	1.52	.144	.003	6,2959	1.66	.128	.003
\$100,000 or more	6.23 (1.46)	4.33 (1.04)									
<b>Race/Ethnicity</b>			Effect of messages:	4,4150	23.43	<.001	.022	3,3112	8.94	<.001	.009
Any other Race/Ethnicity	5.33 (2.00)	3.80 (1.34)	Effect of Race/Ethnicity:	1,1038	13.61	<.001	.003	1,1038	9.48	.002	.003
Non-Hispanic White	5.82 (1.78)	4.07 (1.21)	Interaction:	4,4150	2.56	.037	.002	3,3112	1.33	.262	.001



**Figure 2.** Showing respondents' vaccine interest across the 5 side effect messages according to respondents' self-reported gender (Panel A) and Race/Ethnicity (Panel B). The shaped points represent the mean point estimate with error bars for the 95% confidence interval. The horizontal black dashed lines represent the mean for the baselines message to assist comparison with the mean for the social media message.



[1.25]). None of the other comparisons significantly impacted vaccine confidence ( $ps > .198$ ).

Vaccine confidence was significantly higher for Veteran respondents ( $M = 4.13$ ,  $SD = 1.19$ ) compared to non-Veteran respondents ( $M = 3.84$ ,  $SD = 1.32$ );  $t(3613.27) = 7.21$ ,  $P < .001$ ,  $d = .23$ . Vaccine confidence was also higher for respondents who were older, Male, non-Hispanic White, and with higher reported annual income; however, we found no evidence of any interaction between the vaccine efficacy messages and these variables (see Table 3).

## Conclusions

Vaccine hesitancy has been increasing globally and is recognized as a major public health issue.<sup>41</sup> Currently, hesitancy toward COVID-19 vaccines presents a notable barrier to ending the pandemic.<sup>42</sup> To ensure that as many people as possible receive a COVID-19 vaccine, effective communication about vaccines is crucial for reducing hesitancy, promoting confidence, and increasing uptake. In the present study, we investigated the impact of different messages about COVID-19 vaccine side effects and efficacy on vaccine interest and confidence with a sample of US Veteran and non-Veteran respondents.

Open and accurate reporting of any possible side effects from vaccines is crucial for maintaining public trust and confidence,<sup>11</sup> but may also increase concerns about vaccine safety and foster vaccine hesitancy.<sup>1,12,13</sup> We find evidence that combining messages about possible side effects with information highlighting the benefits of vaccination, reframing the likelihood of experiencing side effects, or explaining that post-vaccine symptoms show the vaccine is working can have a positive influence on vaccine interest. We recommend the addition of this content to online communications about COVID-19 vaccine side effects as it can be easily achieved on webpages (e.g., <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/expect/after.html>; "You may have some side effects, which are normal signs that your body is building protection."). To achieve further outreach, this content can also be applied to other platforms for health messages such as leaflets and posters ([https://www.cdc.gov/coronavirus/2019-ncov/downloads/vaccines/324160-A-COVID-19\\_VaccinationPoster\\_WhatToExpect\\_LTR-6.24.pdf](https://www.cdc.gov/coronavirus/2019-ncov/downloads/vaccines/324160-A-COVID-19_VaccinationPoster_WhatToExpect_LTR-6.24.pdf)), which might provide an important boost in vaccination rates.<sup>43</sup> Discussions with healthcare professionals about potential side effects of vaccines are also important in shaping vaccination intentions of patients and parents.<sup>44,45</sup> Understanding how to communicate effectively with patients and parents is crucial as some strategies may backfire and unintentionally strengthen hesitancy.<sup>46-48</sup> We believe the present findings can also be used to guide health care professionals in conversations as they discuss vaccinations in clinics in order to promote uptake of COVID-19 vaccines.

Furthermore, we find that messages about the efficacy of vaccines absent uncertainty or directing attention to upper

limits of confidence intervals are more effective at increasing confidence in COVID-19 vaccines. However, vaccine confidence remained high for the messages about vaccine efficacy which contained verbal uncertainty and the efficacy range. Recent work has found that people may prefer information about COVID-19 to be communicated with the uncertainty openly acknowledged.<sup>33</sup> In addition, there is growing evidence that communicating uncertainty does not inevitably lead to reduced trust and perceived competence or increased negative feelings (e.g., of vulnerability or panic) as is often feared.<sup>31,32</sup> Thus, we recommend that communicators continue to acknowledge the uncertainty associated with vaccine efficacy (e.g., by presenting ranges around point estimates and using verbal probability terms) in order to avoid promoting excess certainty, as advised by the Crisis and Emergency Risk Communication guidelines issued by the U.S. Centers for Disease Control and Prevention<sup>49</sup> as well as by the National Academies of Sciences, Engineering, and Medicine.<sup>50</sup>

As our sample contained both Veteran and non-Veteran respondents, it was important to consider differences between these populations which could have potentially influenced the present results. For example, at a demographic level, the Veteran population is generally older and there is a greater incidence of chronic disease,<sup>51</sup> both of which are known to increase the risk of severe outcomes from COVID-19 infection. In addition, Veteran and non-Veteran populations also differ regarding their healthcare utilization and in their lived experiences.<sup>52</sup> Overall, we found that Veteran respondents were more interested in getting vaccinated and more confident in the efficacy of COVID-19 vaccines as compared to non-Veteran respondents. This is aligned with prior studies showing higher vaccination rates in the Veteran population<sup>53</sup> and reflects the efforts of the U.S. Department of Veterans Affairs in their response to the COVID-19 pandemic ([https://www.va.gov/health/docs/VA\\_COVID\\_Response.pdf](https://www.va.gov/health/docs/VA_COVID_Response.pdf)). However, despite these differences between the Veteran and non-Veteran populations, we found that the effects of the messages about the side effects and efficacy of COVID-19 vaccines remained consistent between these groups.

The findings from this study should be interpreted with consideration of certain limitations. For instance, the present findings rely heavily on respondents' self-reported attitudes. However, despite known limitations, self-reported attitudes have been shown to be important predictors of health behaviors.<sup>54</sup> It is also important to note that as our sample is primarily representative of older, non-Hispanic White Males, these findings cannot be generalized to the wider population. Our finding that vaccine interest and confidence was lower in younger, Female, lower income, and non-White respondents replicates existing studies which have reported greater hesitancy toward COVID-19 vaccines from these demographic groups.<sup>24,55,56</sup> As these groups were underrepresented in our study, it is particularly important for future research to test communication strategies that are tailored to their unique needs and concerns.<sup>24</sup> Thus, although our findings present a

good starting point, further replication and validation are needed to enhance trust in these results and broaden their generalizability.

Our findings are also unable to offer insight on how to reach people who are strongly opposed to vaccination which remains an important area of study. While clear and transparent messaging about features of the COVID-19 vaccines represents a useful strategy for informing and reassuring people who are hesitant or unsure about getting vaccinated,<sup>9,57</sup> it is unlikely to be effective for addressing the concerns of those who are strongly opposed to getting a COVID-19 vaccine.<sup>24</sup> Instead, addressing the deeply held beliefs, suspicions, and distrust associated with the refusal of COVID-19 vaccines will require extended and personalized efforts to build trust<sup>24</sup> as well as combatting the spread of misinformation and conspiracy beliefs.<sup>58,59</sup> Again, evidence-based tailoring of these approaches to the specific needs and experiences of those most likely to be strongly opposed to COVID-19 vaccines will be critical for their success.

We acknowledge that with a within-subjects design, participants were able to compare all the messages and their responses may also reflect judgments about which message they liked best. As the study was conducted online, participation by people without (or only limited) internet access and those with lower English proficiency was possibly restricted; generalization of the results to these groups or outside of the US is not guaranteed.

Earning public trust in vaccines and public health requires open communication about the risks and benefits of vaccines. Our findings offer important insights regarding how to effectively communicate about the potential side effects and the efficacy of COVID-19 vaccines. The observed effects for the messages about side effects and vaccine efficacy were small but appear to be beneficial accompaniments to information that it is necessary to communicate, continues to be widely shared, and can have negative impacts if communicated poorly. Furthermore, small increases in vaccination interest can have substantial effects at a population level and potentially encourage millions more people to get vaccinated. Thus, we recommend that i) messages about possible side effects from COVID-19 vaccines are provided with information either reframing the likelihood of experiencing side effects, highlighting the benefits of vaccination, or explaining that post-vaccine symptoms show the vaccine is working can have a positive influence on vaccine interest, and ii) messages about the efficacy of vaccines avoid presenting excess certainty regarding point estimates and upper efficacy limits. These recommendations can be easily implemented across a range of mass-communication mediums (e.g., webpages, adverts, leaflets, and posters), and can also guide in-person discussions about vaccine side effects and efficacy in non-clinical as well as clinical settings (e.g., between healthcare professionals and patients). We are also hopeful that these findings will prove valuable for promoting uptake of other vaccines and may help prevent or manage future epidemics and pandemics.

## So What?

### *What Is Already Known on This Topic?*

Communicating about potential side effects and efficacy of COVID-19 vaccines is crucial for promoting transparency and ensuring that people are sufficiently informed about the risks and benefits of vaccination. However, there is currently limited knowledge on the most effective strategies for doing so.

### *What Does This Article Add?*

Our paper adds evidence on effective messaging strategies for communicating about potential side effects associated with COVID-19 vaccines and COVID-19 vaccine efficacy in order to promote confidence and interest in getting vaccinated. Specifically, that messages about potential side effects from COVID-19 vaccines can increase interest in vaccination by focusing on the benefits of vaccination, reframing the likelihood of side effects, or framing post-vaccine symptoms as a good sign the vaccine is working, while messages about the efficacy of COVID-19 vaccines can acknowledge uncertainty and still promote confidence in COVID-19 vaccines.

### *What Are the Implications for Health Promotion Practice or Research?*

We propose a number of recommendations for the use of these strategies in large-scale communications (e.g., webpages, social media, and leaflets/posters) to promote public uptake and also to help guide healthcare professionals when discussing vaccinations in clinics.

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## Authors' Note

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## Declaration of Conflicting Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Ethics statement

The study was approved (deemed exempt) by the IRBs at the University of Utah and the Salt Lake City VA (Veterans Experiences During the COVID-19 Pandemic: IRB\_00133198). Respondents consented to participate in this voluntary study.

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