Running head: PLEASURE OF CHOICE

Testing Two Attention-Related Effects in COVID-19 Vaccine Likelihood

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All data have been made publicly available at the Open Science Framework (OSF). Study materials, data, preregistered hypotheses, and code can be accessed at https://osf.io/3wnft/

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Abstract (word maximum = 150; current = 121)

Two studies (combined *N*=2,044 with online U.S.-based participants) were conducted to test attention-theory-based methods intended to increase vaccine intentions: (1) the presence *vs* absence of having choice; and (2) in choice's absence, the effect of offering a single option and describing it *vs* offering the same option and describing it plus additional options. Consistent with attention-based choice, participants (both unvaccinated and vaccinated) expressed stronger positive affect to the vaccine and greater likelihood to get vaccinated when allowed to choose among multiple vaccines. The pleasure of choice is an overlooked factor when considering how to increase vaccine uptake. In the absence of choice, however, effects were mixed about whether informing about a single vaccine would increase intentions over informing about multiple vaccines.

Keywords: vaccine hesitancy, health communication, choice behavior, affect, attention, decision making

General Audience Summary (maximum = 300 words; current = 142):

Effective vaccines have tremendous potential to control pandemics if supplies are adequate and enough people agree to vaccinate. However, in the latest pandemic, the proportion of people agreeing to vaccinate in the U.S. and elsewhere was low. In the present studies, we relied on two theory-based methods to develop and test hypotheses concerning vaccination intentions. Consistent with our hypothesis about the pleasure of choice, participants expressed stronger positive affect to the vaccine and greater likelihood to get vaccinated when allowed to choose than when not allowed to do so. However, in the absence of choice, effects were mixed when we attempted to split attention by informing about multiple vaccines (thought to decrease vaccination intentions) *vs* a single vaccine. Highlighting the pleasure of choice may be a simple, albeit partial, solution in vaccinated and unvaccinated populations to fighting diseases when multiple vaccines exist.

Testing Two Attention-Related Effects in COVID-19 Vaccine Likelihood

Vaccine hesitancy is associated with lower knowledge and more worry about vaccine efficacy and safety (Ruiz & Bell, 2021). Improved safety and efficacy communication therefore may help (Shoots-Reinhard et al., 2022), but vaccine education is often thought unproductive (Hornsey et al., 2018). As a result, researchers have turned to potential psychological roots, such as conspiratorial thinking, that may uphold antivaccination attitudes. Less considered is the possibility that a more psychologically charged education focus may improve vaccine uptake. Here, we focus on two theory-based methods thought to focus selective attention on vaccine side-effect likelihoods; we test whether these methods—attention focus *vs* splitting and the pleasure of choice—may increase vaccine intentions. Such questions are important for present vaccines and future pandemics as nations struggle with low vaccine uptake.

In particular, we note novel vaccine characteristics introduced with COVID-19. First, prior to COVID-19, it was atypical to know vaccine brands and get to choose one. Thus, we test whether allowing a person to choose between multiple vaccines provides benefits over the absence of choice. Second, it was atypical to have access to a lot of information about multiple vaccine options, even when some options were unavailable. Thus, we test in the absence of choice whether people are more likely to intend to get a specific vaccine when informed about only it *vs* informed about it plus unavailable vaccines. This paper focuses on FDA-authorized COVID-19 vaccines (Pfizer, Moderna [Study 1]; Pfizer, Moderna, Johnson & Johnson [J&J] [Study 2]) as we attempt to demonstrate the practicality of good theory backed by data (Lewin, 1952) in the midst of a global crisis.

At face value, having more information and choice seem beneficial as individuals can better discover what suits their preferences and enjoy greater utility while feeling more

autonomous (Lancaster, 1990; Schwartz, 2004). However, the benefits of more information and choice on vaccine uptake are not guaranteed, despite theory and choice models in psychology and economics positing that larger vaccine choice sets should not make decision makers worse off (Rieskamp et al., 2006; Savage, 1954). More information and options instead may lead to lower comprehension, negative emotions, and an inability to choose due to the cognitive effort required (Iyengar & Lepper, 2000; Peters et al., 2007; Schwartz, 2004).

Attention Focus (One Option) and Attention Splitting (Multiple Options)

In addition, people have limited attention and selectively attend to information (Simon, 1978), with, for example, attention and emotions influencing one another (Phelps, 2006). In particular, focusing attention on one stimulus results in more negative affect (i.e., feelings) towards the other ignored stimuli (Fenske & Raymond, 2006; Fenske et al., 2004, 2005; Goolsby et al., 2006, 2009; Kiss et al., 2007, 2008; Raymond et al., 2005; Veling et al., 2007). The greater negative affect (or reduced positive affect) then may motivate subsequent preferences for the distractor (Peters, 2006; Peters et al., 2006). For example, showing a single child in need of help induced more attention to that child and subsequent greater sympathy and donations than when the same child was shown with other needy children (Dickert & Slovic, 2009; Västfjäll et al., 2014; see also Burson et al., 2013); greater positive affect to the single child mediated the results.

Similarly, a person considering vaccination may face a target available vaccine that is described either with or without an unavailable, distractor vaccine that is also described. In such circumstances, it is reasonable to expect a person to examine information about both described vaccines. However, if attention influences emotion and then emotion influences preferences, we reasoned that the target available vaccine would receive less attention in the presence of a distractor vaccine(s). Thus, attention would be split, with each vaccine being devalued while the

other(s) was being considered so that affect to all vaccines, including the target, would become more negative. This affect then would decrease subsequent vaccine intentions (Peters, 2006; Peters et al., 2006).

Hypothesis 1 (H1): In the absence of choice, participants informed about multiple vaccines would be less likely to intend to vaccinate than those informed about one vaccine. This effect would be mediated by lower positive affect to the target vaccine in multiple-vaccine conditions. (Studies 1-2).

Evaluability

Evaluability offers an alternative prediction (Hsee et al., 1999). In it, quantitative differences between two options have greater effects on evaluation when the options are shown together than in isolation; qualitative attributes, on the other hand, have greater effect in isolation. For example, when shown one-at-a-time, people were willing to pay more for an overfilled cup containing quantitatively less ice cream than an underfilled cup. But, when the cups were shown side-by-side, people were willing to pay more for the larger, underfilled serving (Hsee, 1998). Evaluability specifically concerns effects when options are judged in isolation versus jointly. In the present Study 1, Pfizer was similarly effective and slightly less risky than Moderna (Oliver et al., 2020, 2021). Thus, in joint evaluation, the Pfizer vaccine may be preferred, but when viewing only one vaccine option, participants may perceive little difference between them, thus supporting evaluability. In Study 2, the J&J vaccine had lower effectiveness than the other two vaccines so that it may be evaluated more negatively in joint evaluation than in isolation because numbers exert more influence in joint evaluation than in single evaluation.

Hypothesis 2 (H2): Participants informed about multiple vaccines (*vs* one vaccine in

isolation) would have lower positive affect and vaccine likelihood for less effective vaccines than more effective ones. (Studies 1-2).

The Pleasure of Choice: Attention-Driven Choice and Evaluative Coding

Attention-splitting H1 and evaluability H2 focus on vaccination likelihood among participants provided vaccine information and offered a specific vaccine in the absence of choice. However, the ability to choose may increase perceptions of control and beneficial outcomes (e.g., Williams et al., 1998). People also prefer having choice (Peters et al., 2013) even without additional reward (Bown et al., 2003). Furthermore, simply having choice elevates the affective value of options, recruits reward-related neural circuitry, and increases curiosity (Leotti & Delgado, 2011; Romero Verdugo et al., 2022; Sharot et al., 2009; Wang & Delgado, 2019). Furthermore, stimulus approach is closely linked to increased liking and avoidance to increased disliking (e.g., Chen & Bargh, 1999; Eder & Rothermund, 2008). If one can assume that choosing is similar to approach while not choosing or rejecting is similar to avoidance (Dittrich & Klauer, 2012), then we would predict greater positive affect (liking) for the same option when chosen vs offered in the absence of choice. We hypothesized:

Hypothesis 3: (H3): When presented with multiple vaccines, a chosen option would have higher vaccine likelihood and positive vaccine affect than the same option offered in the absence of choice. (Studies 1-2).

COVID-19 timelines may be critical, and we summarize relevant dates here. At the beginning of Study 1's data collection, the Pfizer vaccine received emergency use authorization (EUA) from the U.S. Food and Drug Administration (FDA) (Day 2) and the first U.S. health care worker was vaccinated with the Pfizer vaccine (Day 6). After Study 1 was completed, the Moderna vaccine was authorized and became available to the public. The J&J vaccine received

authorization later (before Study 2). No vaccine booster was authorized prior to either study.

Study 1

Methods

This study was part of a longitudinal study about reactions to the COVID-19 pandemic (Pohl Duarte et al., n.d.). For it, Amazon Mechanical Turk (MTurk) participants (*N*=1,284) were recruited initially to a baseline survey in February 2020 via CloudResearch (Litman et al., 2017). CloudResearch offers several features to improve data quality (e.g., Hauser et al., 2022; Litman, 2018). To further ensure high-quality participants, we required that participants had a 99%–100% approval rating, had completed 5,000 to 10,000 HITs (i.e., "Human Intelligence Tasks," the tasks completed by MTurk users), were over age 18, and were within the United States. For each wave, we excluded those who failed two or more attention checks and/or gave nonsense responses, who reported using a calculator or looking up answers, and/or who had an IP address outside the United States.

Procedure

Baseline participants provided demographics (e.g., age, gender, political ideology). Because expected effect sizes were unclear, all baseline participants were invited; 60% (final *N*=771 after exclusions) responded to a 28-minute survey from December 10-18, 2020. They were paid $4 plus a $2 completion bonus. They were asked about affect and risk perceptions toward SARS-CoV-2, likelihood of protective behaviors, perceived effectiveness of protective behaviors, media use, and other questions; then, they completed Study 1. Informed consent for both studies was obtained as approved by the University of Oregon Institutional Review Board.

Experimental Conditions

Participants were randomized to one of five conditions (see Table 1). In two one-vaccine conditions, they read risk and effectiveness information about a single vaccine (Pfizer or Moderna). The vaccines were described as similarly effective (respectively, 95% or 94%); Pfizer had somewhat lower likelihood of side effects (e.g., 4% or 10% likelihood of fatigue, respectively). In two two-vaccine no-choice conditions, participants read about the Pfizer vaccine then Moderna. We chose this fixed order—describing Pfizer first and then Moderna—because at this very early date at the beginning of the vaccine rollout, most communications indeed mentioned Pfizer and then Moderna, presumably because Pfizer came out first with their vaccine. In the two-vaccine choice condition, participants read the Pfizer description, then the Moderna description, and were asked to choose a vaccine. All participants then were asked about their likelihood to get the vaccine they were offered or chose (depending on condition), COVID-19 risk perceptions, and then questions about their offered or chosen vaccine (affect, perceived benefits and risks, trust). In the two-vaccine conditions, they were also asked the same questions about the other vaccine after answering all questions about the target vaccine. For vaccine descriptions, see Table 2; additional stimulus materials are in **Supplemental Text 1**.

Table 1. Description of conditions and sample sizes (*n*) by study conditions with hypotheses tested.

Conditions	Study 1 *n*	Study 2 Vaccinated *n*	Study 2 Unvaccinated *n*	Hypotheses tested
No-choice Conditions				
One Vaccine, No-choice				
Pfizer	152	73	36	H1, H2
Moderna	155	73	37	H1, H2
Johnson & Johnson (J&J)		75	39	H1, H2
Two Vaccines, No-choice				
Pfizer, Moderna; given Pfizer	153	72	35	H1, H2, H3
Pfizer, Moderna; given Moderna	152	69	37	H1, H2, H3
J&J, Pfizer; given J&J		73	36	H1, H2, H3
J&J, Pfizer; given Pfizer		69	35	H1, H2, H3
J&J, Moderna; given J&J		70	32	H1, H2, H3
J&J, Moderna; given Moderna		72	37	H1, H2, H3
Three Vaccines, No-choice				
Pfizer, Moderna, J&J; given Pfizer		69	36	H1, H2, H3
Pfizer, Moderna, J&J; given Moderna		73	34	H1, H2, H3
Pfizer, Moderna, J&J; given J&J		72	34	H1, H2, H3
Choice Conditions				
Two Vaccines, Choice				
Pfizer, Moderna	159	69	35	H3
J&J, Pfizer		69	32	H3
J&J, Moderna		71	33	H3
Three Vaccines, Choice				
Pfizer, Moderna, J&J		75	36	H3

Table 2. Vaccine descriptions from Study 1 and example descriptions from Study 2 (see https://osf.io/3wnft/ for full information under what was pre-registered as Study 3)

Study 1	Study 2
Pfizer. Below is a summary of an initial finding testing one of COVID-19 vaccines, made by Pfizer. Please read the information carefully. You will be asked questions about it. November 2020, the pharmaceutical company, Pfizer, announced findings of their COVID-19 vaccine. The study enrolled close to 44,000 people. Half of the people got the vaccine, which was given in two doses; the other half got a placebo of salt water. None of the study participants, doctors or company top executives knew who got the vaccine or the placebo. Out of nearly 44,000 people in the trial, 170 got Covid-19. An independent group of experts found out which of these individuals with COVID-19 got the vaccine or the placebo (i.e., salt water). These experts concluded that the vaccine was about 95% effective at preventing COVID-19. It worked equally well across age, gender, race, and ethnicity demographics. It was also well tolerated with no serious safety concerns. A small proportion of patients did experience minor side effects that did not last long; specifically, about 4% of patients had fatigue and 2% had headaches. The vaccine needs to be kept at an extremely cold temperature, minus 94 degrees Fahrenheit, much colder than a regular freezer.	Pfizer. Below is a summary of findings after testing one of the COVID-19 vaccines, made by Pfizer. Please read the information about it below carefully. You will be asked questions about the vaccine. Based on a clinical trial, the vaccine was **95% effective** at preventing COVID-19. It also worked equally well across age, gender, race, and ethnicity demographics. The vaccine was also well tolerated with no serious safety concerns. Most side effects were experienced by a minority of people and did not last long. See the bar chart below for more information about side effects after the first vaccine shot. The vaccine needs to be kept at an extremely cold temperature (-94°F), much colder than a regular freezer.
Moderna. Below is a summary of an initial finding testing one of COVID-19 vaccines, made by Moderna. Please read the information carefully. You will be asked questions about it. Moderna. In November 2020, the pharmaceutical company Moderna announced its initial findings of their COVID-19 vaccine. The study enrolled 30,000 people. Half of the people got the vaccine, which also consists of two doses; the other half got a placebo. None of the study participants, doctors or company top executives know who got the vaccine or the placebo. To date, out of 30,000 people in the trial, 95 got Covid-19. An independent group of experts found out which of these individuals with COVID-19 got the vaccine or the placebo. These experts concluded that the vaccine was about 94% effective at preventing COVID-19. It worked equally well across age, gender, race, and ethnicity demographics. A small proportion of patients did experience minor side effects that did not last long; specifically, about 4% of patients had injection site pain, 10% had fatigue, 9% had muscle pain, 5% had joint pain, and 5% had headaches. The vaccine needs to be kept at a cold temperature, minus 4 degrees Fahrenheit, like a regular freezer.	Moderna. Below is a summary of findings after testing one of the COVID-19 vaccines, made by Moderna. Please read the information about it below carefully. You will be asked questions about the vaccine. Based on a clinical trial, the vaccine was **94% effective** at preventing COVID-19. It worked equally well across age, gender, race, and ethnicity demographics. The vaccine was also well tolerated with no serious safety concerns. Most side effects were experienced by a minority of people and did not last long. See the bar chart below for more information about side effects after the first vaccine shot. The vaccine needs to be kept at a cold temperature (-4°F), like a regular freezer.
	Johnson & Johnson. Below is a summary of a findings testing one of COVID-19 vaccines, made by Johnson & Johnson. Please read the information about it below carefully. You will be asked questions about the vaccine. Based on a clinical trial, the vaccine was **66% effective** at preventing COVID-19. It also worked equally well across age, gender, race, and

	ethnicity demographics. The vaccine was also well tolerated. Most side effects were experienced by a minority of people and did not last long. See the bar chart below for more information about side effects after the single vaccine shot. Women younger than 50 years old should be aware of the rare risk of blood clots after vaccination (.0002% or 2 out of 1,000,000 people getting the shot). The vaccine needs to be kept at a cold temperature, around 36°F, like a normal refrigerator.

Measures

At baseline, participants were asked political ideology (1=very conservative, 4=very liberal), age (free response), gender identification (male=0, female=1, otherwise missing), educational level (1= < high school degree, 5= > a 4-year college degree), and all applicable racial/ethnic groups (i.e.., Asian, Black/African American, Hispanic, Native American/Alaskan Native, Native Hawaiian/Other Pacific Islander, White/Caucasian, Other). Participants who only selected "White" were coded 1=Non-Hispanic white, with other responses 0=Non-white.

Study 1 Data Collection

Pre-Intervention Measure

Vaccine likelihood for the self. "If a COVID-19 vaccine was free to the public, how likely would you be to take it? [Note that the vaccine requires taking two doses, spaced two weeks apart]." 1=completely impossible, 2=quite unlikely, 3=somewhat unlikely, 4=somewhat likely, 5=quite likely, 6=completely certain.

Post-Intervention Measures

Vaccine Choice. In the choice condition, participants first were asked "If you were going to get vaccinated, which vaccine would you choose?" 1=definitely Pfizer to 6=definitely Moderna.

Vaccine Likelihood for the Self. Same question as at pre-intervention.

Coronavirus Risk Perceptions. "I think my chances of getting harmed by the coronavirus are" 1=completely impossible to 6=completely certain.

Affect to Vaccine. "Overall, how does the Pfizer (or Moderna) vaccine make you feel?" 1=extremely bad to 6=extremely good.

Vaccine Benefits. "If you took the Pfizer (or Moderna) vaccine, how effective would it be at preventing you from getting COVID-19?" 1=not at all effective to 5=completely effective.

Vaccine Risk Perceptions. An index was formed of three items: Risk likelihood ("If you took the Pfizer (or Moderna) vaccine, how likely are you to experience side effects?" 1=no chance to 6=certain to happen); Risk severity ("If you did experience side effects from the Pfizer (or Moderna) vaccine, how severe would they be?" 1=not at all severe to 6=extremely severe); and Unknown risks ("Do you agree or disagree that the Pfizer (or Moderna) vaccine likely has some yet unknown serious side effects?" 1=strongly disagree to 6=strongly agree). Cronbach's α=.78.

Lifetime Vaccine Benefits. "Would getting the Pfizer (or Moderna) vaccine stop you from getting COVID-19 for the rest of your life?" 1=definitely no to 6=definitely yes.

Trust. "How much do you trust the results of the Pfizer (or Moderna) vaccine trial?" 1=not at all to 6=completely.

Statistical Analysis

Study 1 was not pre-registered. In it, we regressed vaccine likelihood for the self onto similar demographics to that used in a nationally representative sample (Ruiz & Bell, 2021). Based on this analysis, all analyses controlled for education, race, gender, political ideology, and age; we also controlled for pre-intervention likelihood. Our primary dependent variable was post-intervention vaccine likelihood.

We then simultaneously tested attention-splitting H1 (that, in the absence of choice, participants informed about multiple vaccines would be less likely to intend to vaccinate than those informed about one vaccine) and evaluability hypothesis H2 (that participants informed

about one vaccine in isolation *vs* it in the context of multiple vaccines) would have lower [higher] positive affect and vaccine likelihood if it was less [more] effective than other vaccines) by conducting analysis of covariance (ANCOVA) with Bonferroni corrections. For attention-splitting H1, we compared the one-vaccine no-choice conditions to the two-vaccine no-choice conditions. To test evaluability H2, we further coded whether Pfizer or Moderna was available and examined the interaction of the two dummy variables. Similar analyses were conducted with affect to the target vaccine and exploratory variables as dependent variables. If H1 was supported, we used PROCESS macro in SPSS Model 4 version 24 for Windows to examine whether affect mediated the effect of the number of vaccines on vaccine likelihood. Mediation analyses were conducted using the bootstrapping method with 5,000 iterations. Bootstrap confidence interval (CI) levels at 95% indicate significant indirect effects when estimates do not contain zero (Hayes, 2017).

Finally, to test pleasure-of-choice H3 (that in the presence of choice, people would report greater vaccination likelihood and more positive vaccine affect than in its absence), we conducted separate ANCOVAs of vaccine likelihood and affect in multiple-vaccine conditions, comparing the choice to the two no-choice conditions. For descriptive purposes, if H3's test was significant, we conducted a logistic regression of vaccine likelihood responses of "5=Quite likely" or "6=Completely certain" to estimate the proportion of participants in each condition with high vaccine likelihood.

Results

Demographics

Participants (*N*=771) were 48.7% males (0.9% missing) and averaged 41 years (*SD*=13). They were mostly White (79%), followed by more than one racial/ethnic background (10.1%),

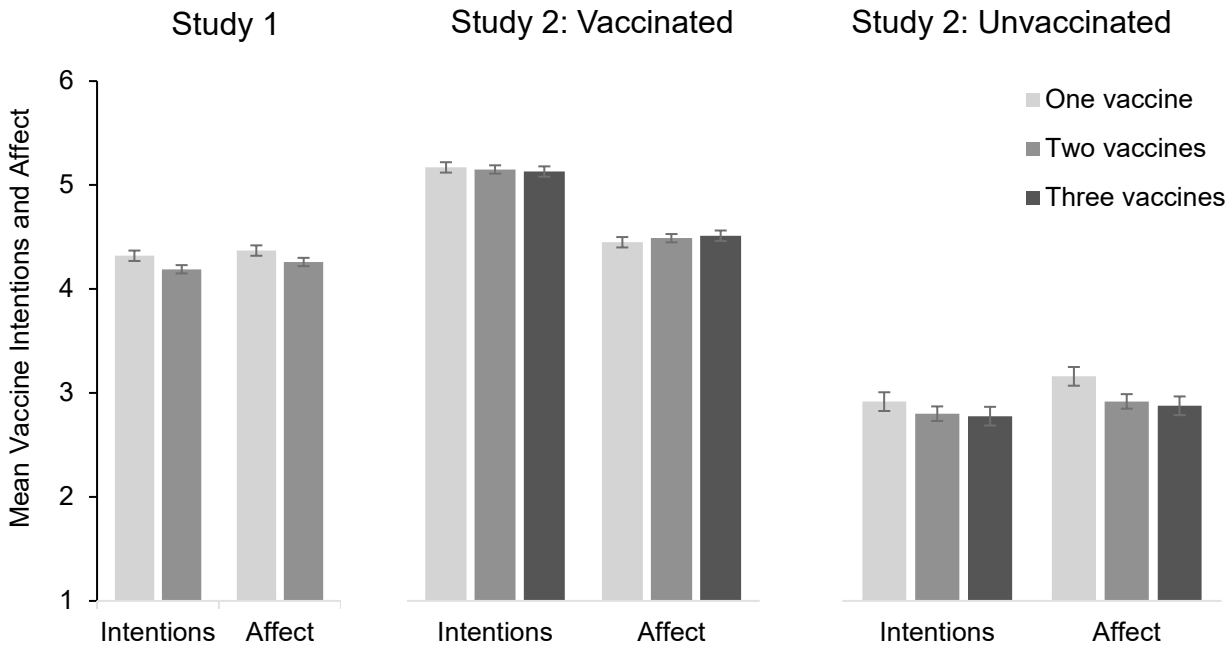
African American (7%), Hispanic (3.1%), and other (.6%). On average, participants reported having less than a 4-year college degree (M=3.62, SD=.90 where 3=some trade school/college and 4=4-year college degree) and being more liberal (M=2.70, SD=.80). Vaccine likelihood averaged 4.29 (SD=1.63). **Supplemental Text 3** and **Table S1** describe predictors of vaccine likelihood, which was higher among liberals, the more educated, females, non-Hispanic whites, and older adults.

Testing Attention-Splitting H1 (Number of Vaccines) and Evaluability H2 in the Absence of Choice

We first tested H1 and H2 simultaneously among participants in the two one-vaccine conditions and the two two-vaccine no-choice conditions (n=602). Overall and consistent with H1 (in the absence of choice that people would have stronger vaccine likelihood when told about one rather than two vaccines), vaccine likelihood was higher when told about one vaccine (M=4.32, SE=0.03) than about both vaccines (M=4.19, SE=0.03; $F(1,592)=8.86$, p=.003, η_p^2=.02; Figure 1). For descriptive purposes, we conducted the same analysis as a logistic regression of those quite likely or completely certain to get vaccinated (vs responding with a lower likelihood). In the absence of choice, 46.5% of participants were highly likely to get vaccinated in the one-vaccine conditions compared to only 25.8% in the two-vaccine no-choice conditions at mean levels of all other variables.

Figure 1.

Effects of the Number of Vaccines Described on Mean Intentions and Affect Ratings (Both on 1-6 Scales) in the Absence of Choice.



Note: Estimated marginal means are reported; error bars indicate standard errors of the estimated marginal means. Covariates are held at their mean level; effects of covariates appear in **Tables S4**, **S8**, and **S11**.

However, inconsistent with H1, nonsignificant differences emerged in positive vaccine affect when told about one vaccine (M=4.37, SE=0.05) vs both vaccines (M=4.26, SE=0.05; $F(1,592)=2.41$, $p=.121$, $\eta_p^2=.004$). Therefore, mediation analysis was not conducted. Although not the focus of an hypothesis, people also had higher vaccine intentions, more positive affect, and lower risk perception when offered Pfizer than Moderna (respective intention Ms=4.33,

SE=.03 and 4.18, *SE*=.03; respective positive affect *M*s=4.40, *SE*=.05 and 4.23, *SE*=.05; respective risk perceptions *M*s=3.03, *SE*=.05 and 3.20, *SE*=.05). See **Table S2** and **Table S4** for statistical details.

Given null affect results, we explored the possibility that the presence of multiple vaccines compared to a single vaccine might confer greater feelings of safety (i.e., lower COVID-19 risk perceptions) or greater trust in the vaccines. The former logic is consistent with economic theory (Lancaster, 1990) and usual assumptions in public policy that more (of something) would produce better outcomes (Peters et al., 2013); the latter results could be consistent with findings of target faces being trusted more than distractors (Fenske & Raymond, 2006). However, all other effects of two *vs* one vaccine in the absence of choice were nonsignificant (**Table S3**).

Inconsistent with evaluability H2 (that quantitatively better Pfizer would elicit greater likelihood and positive affect than Moderna in the two-vaccine *vs* one-vaccine conditions), a nonsignificant interaction emerged between the two dummy variables for vaccine likelihood ($F(1,592)=0.00$, $p=.950$) and affect ($F(1,592)=0.01$, $p=.936$). A small significant interaction emerged in predicting vaccine efficacy ($F(1,592)=4.49$, $p=.035$), but the effect was opposite the direction predicted by evaluability. See **Tables S2** and **S4** for further statistical details.

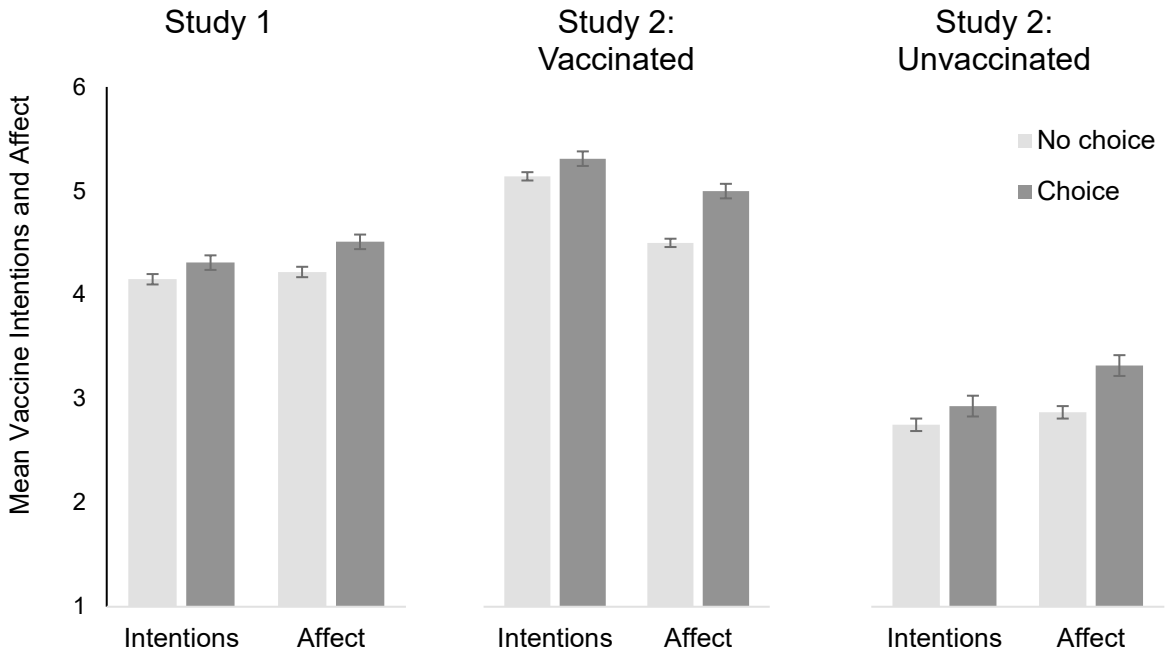
Separate Test of Pleasure-of-Choice H3

First, 79% of people in the two-vaccine choice condition chose Pfizer. We then tested H3 among participants in the two two-vaccine no-choice conditions with those in the two-vaccine choice condition (n=454). Consistent with H3, vaccine likelihood was higher in the two-vaccine choice condition (M=4.31, SE=0.04) than the two-vaccine no-choice conditions (M=4.15, SE=0.03; $F(1,446)=11.19$, $p=.001$, $\eta_p^2=.02$) (Figure 2; **Table S3**; **Table S5** contains covariate

effects). In particular, 44.0% of choice participants were predicted to be quite likely to completely certain to get vaccinated compared to only 22.8% of no-choice participants. Vaccine affect also was more positive in the choice than no-choice conditions (respectively, M=4.51, SE=.07 and M=4.22, SE=.05; $F(1,445)=10.70$, p=.001, η_p^2=.02). Furthermore, affect mediated the effect of choice condition on intentions (IE=0.05, SE=0.02, 95%CI=0.02, 0.08). Finally, some support was seen for choice inducing a spreading of alternatives (**Supplemental Text 4**).

Figure 2.

Effects of the Presence Vs Absence of Choice in Multiple Vaccine Conditions on Mean Vaccine Intentions and Affect Ratings.



Note: Estimated marginal means are reported; error bars indicate standard errors of the estimated marginal means. Covariates are held at their mean level; effects of covariates appear in **Tables**

S5, **S9**, and **S12**.

Discussion

Results very early in the COVID-19 vaccine rollout (when only the Pfizer vaccine thus far had been granted Emergency Use Authorization) supported the beneficial effects of describing a single vaccine *vs* multiple vaccines in the absence of choice, partly consistent with our attention-splitting H1 (the affective portion of H1 was not supported). The hypothesized pleasure of choice was fully supported; compared to the same vaccines in the absence of choice, participants reported being more likely to vaccinate and had greater positive vaccine affect towards their chosen option when allowed to choose.

In an independent study (Study 1a in **Supplemental Text 5**, **Table S6**, and **Table S7**), we attempted to replicate these results without any quantitative information about effectiveness or side effects. At this point (February 18, 2021), the vaccines were relatively well known, and vaccine differences might have been retrievable from memory, allowing similar effects to emerge. However, no significant effects emerged. Presumably because decision makers tend to use information as provided, Study 1a's sparse information—only vaccine brand names were provided—may not have allowed for the quantitative comparisons and/or elaborative processing needed for effects to emerge. Thus, effects of the number of vaccines in the absence of choice and of the pleasure of choice existed only when participants had sufficient information about choice options provided to them. Unclear is what quantity of information would be sufficient.

Study 2 – Vaccinated and Unvaccinated Samples

In Study 2, we tested the three vaccines with emergency use authorization in the U.S. By this time, Americans had greater vaccine knowledge and familiarity, more people were

vaccinated, and greater political polarization existed. We re-examined our three hypotheses separately in vaccinated and unvaccinated samples.

Methods

Participants responded to a 10-minute survey and were paid $2 from Amazon Mechanical Turk via CloudResearch from June 8-9, 2021.

Based on Study 1's effect sizes and the subsequent preregistered power analysis, we needed 561 vaccinated participants and 561 unvaccinated participants to power the test of attention-splitting H1 and 620 participants each to power the pleasure-of-choice H3 test (see https://osf.io/3wnft/; this study was described as Study 3 and hypotheses as H1 and H2, respectively); we unintentionally did not preregister evaluability H2. However, more people were vaccinated in our sample than expected and budget limits ultimately resulted in recruitment of N=1,708 participants (n=564 unvaccinated and 1,144 vaccinated). H1 and H2 tests apply only to participants not allowed to choose (n=425 unvaccinated and n=848 vaccinated) and, for H3, only to participants who saw two or more vaccines and were allowed or not allowed to choose (n=449 unvaccinated and n=914 vaccinated). Thus, adequate (≥80%) power existed to test hypotheses only among the vaccinated.

Procedure and Measures

Study 2 used Study 1's same procedure and measures with a few exceptions. First, participants were asked if they had been vaccinated. For previously-vaccinated participants, the vaccines then were presented as booster shots (although no booster shots were yet authorized). Second, everybody was given more complete side-effect information. Third, after the pre- and post-intervention vaccine likelihood questions, participants—if they did not indicate they were completely certain to get the vaccine or booster—were asked their thoughts about getting

vaccinated (e.g., undecided, haven't thought about it). After responding to questions about the target vaccine, they were asked the Study 1 questions, omitting lifetime efficacy, severity of risk, and unknown risk questions. Political ideology was assessed on a 1-7 scale with higher scores being more conservative (the opposite of Study 1).

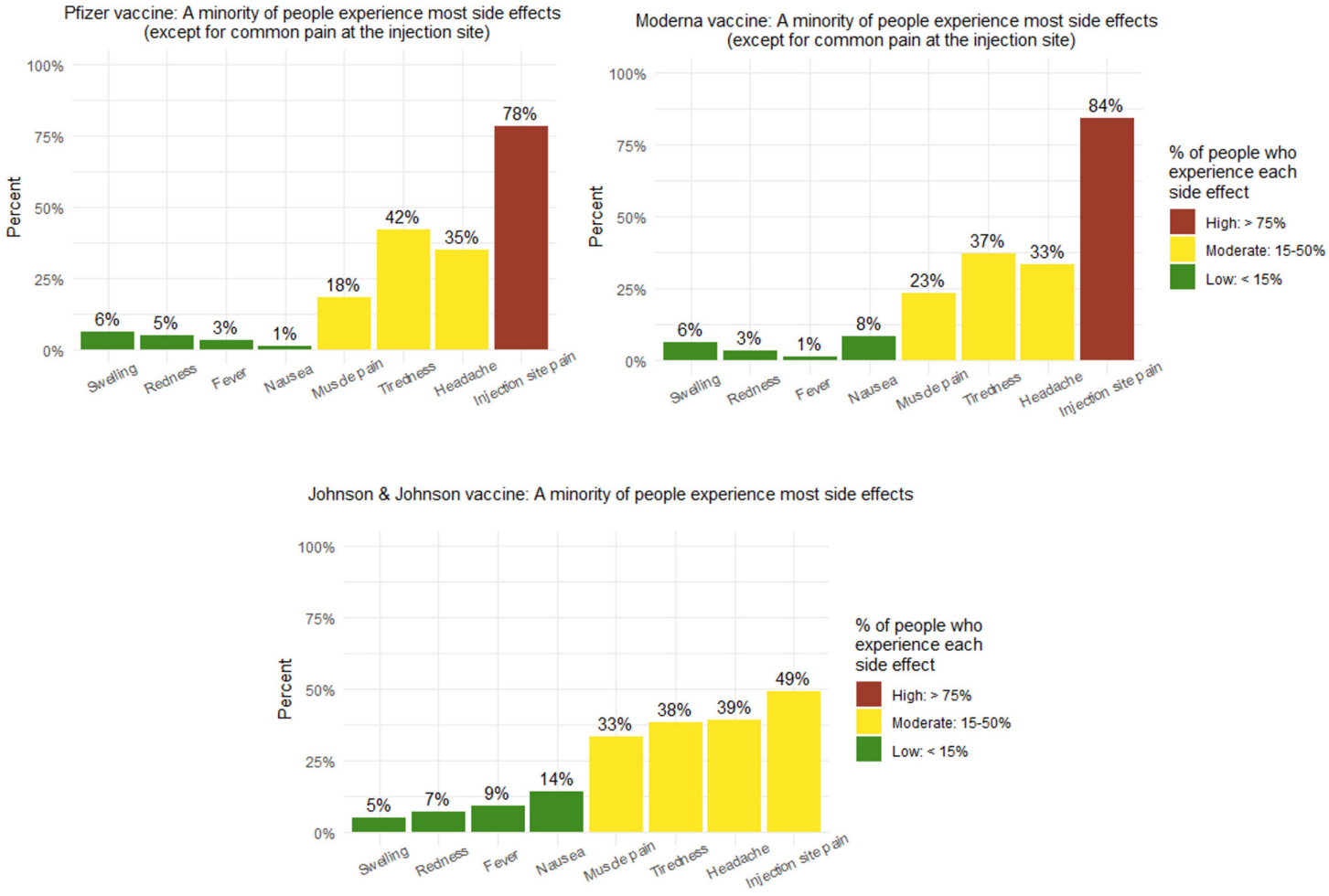
Experimental conditions

The study consisted of 16 experimental conditions randomly assigned separately within vaccinated and unvaccinated participants (Table 1). We included all three vaccines available on the market at the time of the study—Pfizer, Moderna, and J&J. Twelve no-choice conditions (three one-vaccine conditions; six two-vaccine conditions, and three three-vaccine conditions) were designed in a similar manner as Study 1. Compared to Study 1, however, the text was briefer (Table 2); for multiple vaccines, their information was intermingled information rather than presenting one vaccine and then the other; we also included more complete side-effect information in bar-chart form for all vaccines (Figure 3). For example, besides the bar charts, a three-vaccine condition included "Below is a summary of findings after testing three of the COVID-19 vaccines, made by Pfizer, Moderna, and Johnson & Johnson. Please read the information about them below carefully. You will be asked questions about the vaccines. Based on clinical trials, the Pfizer vaccine was **95% effective**, the Moderna vaccine was **94% effective**, and the Johnson & Johnson vaccine was **66% effective** at preventing COVID-19. They also worked equally well across age, gender, race, and ethnicity demographics. The vaccines were also well tolerated with no serious safety concerns for the Pfizer and Moderna vaccines. Most side effects were experienced by a minority of people and did not last long. See the bar chart of each vaccine below for more information about side effects after the first vaccine shot of Pfizer and Moderna and the single shot of Johnson & Johnson. For the Johnson & Johnson vaccine,

women younger than 50 years old should be aware of the rare risk of blood clots after vaccination (.0002% or 2 out of 1,000,000 people getting the shot). The Pfizer vaccine needs to be kept at an extremely cold temperature (-94°F), much colder than a regular freezer. The Moderna and Johnson & Johnson vaccines need to be kept at a cold temperature (-4°F and 36°F, respectively), like a normal freezer and refrigerator." As in Study 1, the vaccines were mentioned in a fixed order based on the time they came on the market (Pfizer, Moderna, then J&J).

Figure 3.

Study 2 Side-Effect Information for the Three Vaccines. Likelihood Information Was From CDC Webpages and Based on the First (Or Only) Shot Received (CDC, 2021, 2022a, 2022b). All three CDC websites are in the public domain.



Statistical Analysis

All pre-registrations, materials, data, and syntax are on Open Science Framework: https://osf.io/3wnft/. **Supplemental Text 2** contains information about preregistration deviations. We conducted hypothesis tests separately in vaccinated and unvaccinated groups.

In each group, we simultaneously tested attention-splitting H1 (that, in the absence of choice, participants informed about multiple vaccines would be less likely to intend to vaccinate than those informed about one vaccine) and evaluability hypothesis H2 (that participants informed about one vaccine in isolation *vs* it in the context of multiple vaccines) would have

lower [higher] positive affect and vaccine likelihood if it was less [more] effective than other vaccines) by conducting analysis of covariance (ANCOVA) with Bonferroni corrections. For attention-splitting H1, we used the number of vaccines in no-choice conditions as a factor, comparing responses when provided one, two, or three vaccines. To test evaluability H2, we used vaccine offered (Pfizer, Moderna, or Johnson & Johnson) as a factor and examined the interaction of the two dummy variables. Similar analyses were conducted with affect to the target vaccine and exploratory variables as dependent variables. Each analysis also controlled for pre-intervention likelihood, race, gender, age, education, and ideology.

Finally, to test pleasure-of-choice H3 (that in the presence of choice, people would report greater vaccination likelihood and more positive vaccine affect than in its absence), we conducted separate ANCOVAs of vaccine likelihood and affect in multiple-vaccine conditions, comparing the four choice conditions to the nine no-choice conditions that described more than one vaccine; the presence of 2 *vs* 3 vaccines and the interaction of number with choice vs no-choice also were included in the analysis, controlling for pre-intervention likelihood, race, gender, age, education, and ideology. For descriptive purposes, if H3's test was significant, we conducted a logistic regression of vaccine likelihood responses of "5=Quite likely" or "6=Completely certain" (=1; vs lower=0) to estimate the proportion of participants in each condition with high vaccine likelihood.

Results

Mean Results

Among the vaccinated (N=1,144), booster likelihood was high (*M*=5.19, *SE*=.03) where 5=quite likely and 6=completely certain, suggesting a possible ceiling effect. The proportion of participants who had Pfizer, Moderna, J&J, or were unsure was, respectively, 51.7%, 39.2%,

8.5%, and 0.6%. Among the unvaccinated *(N*=564*)*, likelihoods to get vaccinated were low (*M*=2.82, *SE*=0.62) where 2=quite unlikely, 3=somewhat unlikely, and 4=somewhat likely.

Testing Attention-Splitting H1 and Evaluability H2 in the Absence of Choice

Vaccinated Participants. We then tested H1 and H2 among only vaccinated participants in one of the twelve no-choice conditions (*n*=848; see Table 1). Inconsistent with H1 (that people would have stronger vaccine likelihood when told about one than multiple vaccines), neither vaccine-booster likelihood, *p*=.807, nor vaccine affect, *p*=.799, differed based on the number of booster vaccines described (Figure 1). Inconsistent with evaluability H2 (that quantitatively better Pfizer and Moderna would elicit greater likelihood and affect than J&J when they were evaluated jointly with J&J in the two- and three-vaccine conditions compared to in isolation in the one-vaccine conditions), a nonsignificant interaction emerged between the two dummy variables, *p*=.673 and *p*=.273, respectively, for likelihood and affect. No exploratory outcomes differed between conditions (**Tables S2** and **S8**).

Unvaccinated Participants. The unvaccinated sample was underpowered to detect effects. Nonetheless, we provide results to understand the direction of effects **(Supplemental Text 7**). H1 was not supported among the unvaccinated; describing one vs more vaccines in the no-choice conditions (*n*=425) did not increase vaccine likelihoods (p=.078) or affect (p=.058; Figure 1; **Tables S2** and **S11**). Evaluability H2 also was not supported; quantitatively better Pfizer and Moderna did not elicit greater likelihoods (p=.147) or affect (p=.442) compared to J&J in the two- and three-vaccine conditions compared to the one-vaccine condition.

Testing H3 (That Booster Vaccine Likelihood Would be Higher in the Presence vs Absence of Choice)

Vaccinated Participants. Consistent with pleasure-of-choice H3, vaccinated participants in the presence of choice (n=914) reported greater booster vaccine likelihood than in its absence (respective M=5.31, SE=.04 and M=5.14, SE=.02, $F(1,904)=14.31$, $p<.001$, $\eta_p^2=.02$; Figure 2). The logistic analysis controlling for pre-intervention likelihood and demographics revealed that 93.5% of vaccinated participants in the choice conditions were predicted to be quite likely or completely certain to get the booster compared to 87.1% in the no-choice conditions. The main effect of number of vaccines and its interaction with presence/absence of choice were nonsignificant (**Tables S3** and **S9**).

Also consistent with H3, affect to the target vaccine was more positive in the choice than no-choice conditions (M_{choice}=5.00, SE=.07; $M_{no\text{-}choice}$=4.50; SE=.04; $F(1,904)=38.16$, $p<.001$, $\eta_p^2=.04$; Figure 2). Neither the number of vaccines (two vs three), p=.157, nor its interaction with choice, p=.265, were significant (**Tables S3** and **S9**). Affect mediated the effect of choice condition on intentions (IE=0.09, SE=0.02, 95%CI: 0.05, 0.14).

In exploratory outcomes, vaccine trust was higher in the presence vs absence of choice (M_{choice}=4.50, SE=.07, $M_{no\text{-}choice}$=4.26, SE=.04; $F(1, 904)=9.50$, p=.002, $\eta_p^2=.01$) as were perceived benefits of the vaccine (M_{choice}=3.94, SE=.04, $M_{no\text{-}choice}$=3.69, SE=.03; $F(1, 904)=25.97$, $p<.001$, $\eta_p^2=.03$). The pleasure of choice did not emerge in analyses of any other exploratory outcome (e.g., risk perceptions; **Tables S3** and **S9**).

Unvaccinated Participants. H3 was supported among unvaccinated participants who were allowed to choose *vs* not allowed to choose (n=449); having choice led to greater vaccination likelihoods (M_{choice}=2.93 and $M_{no\text{-}choice}$=2.75, F(1,439)=11.06, p=.001) and positive

vaccine affect (M_{choice} = 3.32 and $M_{no\text{-}choice}$=2.87, F(1,439)=15.12, p<.001) among the unvaccinated (Figure 2; **Tables S3** and **S12**). Affect mediated the effect of choice condition on intentions (*IE*=0.07, *SE*=0.03, 95%CI: 0.03, 0.13).

Could Comparison Effects Explain Pleasure-of-Choice Results?

Vaccinated participants. **Supplemental Text 6** and **Table S10** explore possible comparison effects of J&J's presence as an alternative explanation of these pleasure-of-choice results among the vaccinated (Note that this would not be an evaluability effect which would require comparing multiple-vaccine conditions to single-vaccine conditions). Specifically, we considered whether the results could be due to participants stating low vaccine likelihood when offered the less efficacious J&J (compared to when offered Pfizer or Moderna) in the no-choice conditions and choosing Moderna and Pfizer more often in the choice conditions (with their associated higher likelihoods); this pattern could mimic the hypothesized pleasure of choice. We examined reported vaccine likelihoods in each condition (J&J/Moderna, J&J/Pfizer, Moderna/Pfizer, J&J/Moderna/Pfizer) when each vaccine was offered and when participants chose. Support for our pleasure-of-choice hypothesis would come from cases when vaccine likelihood was higher when participants chose than when offered a non-J&J vaccine (in J&J's presence); support for the comparison process would emerge when vaccine likelihood was lower, in the absence of choice, when offered J&J than either other vaccine. Analyses suggested J&J's presence did not explain results when two vaccines were described but may have explained the effect in the three-vaccine conditions. In all cases, however, mean vaccine likelihood was highest in choice than no-choice conditions involving J&J.

Unvaccinated Participants. Again, the presence of the less beneficial J&J vaccine might explain pleasure-of-choice results when participants considered all three vaccines, but not when

they considered only two vaccines (**Supplemental Text 8**). However, mean vaccine likelihood was highest in all choice conditions involving J&J than no-choice conditions involving it.

Discussion

Tests of attention-splitting H1 (that vaccine likelihood would be higher when shown only one vaccine vs more vaccines in the absence of choice) were not supported in the vaccinated group who may have had stronger attitudes to vaccination, vaccine brands, or side effects in Study 2 than Study 1. Tests with unvaccinated participants were also nonsignificant but underpowered.

Although J&J's efficacy was lower than the other two vaccines, evaluability H2 also was not supported in either sample. Quantitatively better Pfizer and Moderna did not elicit greater likelihood and affect compared to J&J when shown multiple vaccines vs one vaccine.

Pleasure-of-choice H3 replicated in both samples; people reported greater vaccine likelihood in the presence vs absence of choice. The effects in the two-vaccine conditions did not appear driven by J&J's presence. Thus, giving people a choice among vaccines had a positive effect compared to not giving them a choice. Although the vaccinated group neared ceiling for reported likelihood of getting a booster, low rates for COVID-19 boosters—including in vulnerable populations—highlights the potential importance of these results.

The results, however, may indicate a boundary condition. Pfizer and Moderna had similar efficacy and side-effect profiles whereas J&J had substantially worse efficacy and somewhat less likely side effects. When only the very similar Moderna and Pfizer boosters were described to vaccinated participants, the pleasure-of-choice effect was not obvious (**Table S10**). It may be that more pleasure is derived from easier choices, such as between the inferior J&J vaccine and

either Moderna or Pfizer vaccines. Consistent with this notion, a comparison effect seemed to explain pleasure-of-choice effects when all three vaccines were described.

General Discussion

The pleasure-of-choice hypothesis received robust support in the two-vaccine conditions across Studies 1 and 2 in the deeply relevant domain of COVID-19 vaccines. Vaccine likelihood and positive vaccine affect were higher in the presence vs absence of choice. Increasing booster-shot likelihood may not be as important as increasing vaccine likelihoods among the unvaccinated, but it is important and having choice increased vaccine likelihoods in both samples. These results are consistent with several competing explanations, namely that choice: (1) produces greater positive affect for a chosen option and more negative affect for a rejected one (Dittrich & Klauer, 2012); (2) elevates the affective value of options and recruits reward-related neural circuitry (Leotti & Delgado, 2011; Sharot et al., 2009); (3) increases curiosity and drives better choices (Romero Verdugo et al., 2022); (4) increases certainty due to perceived information completeness (e.g., Rucker et al., 2014); and/or (5) individuals given choice may have looked longer at the vaccines with attention then driving positive affect and greater value perceptions (Krajbich et al., 2010). Because focusing attention on one stimulus also can result in more negative affective evaluations of other ignored stimuli (Fenske & Raymond, 2006; Krajbich et al., 2010), vaccine efforts should emphasize that rejected options may be good options later (Dittrich & Klauer, 2012). Alternatively, these data may be explained in part by a selection effect, with more people getting what they want with choice (and their preferred option was available to them) than without.

This latter explanation, however, seems less likely given that less support was seen for the pleasure of choice when all three options were available (and in Study 2's pairing of the

Pfizer and Moderna vaccines). As described in **Supplemental Texts 6** and **8**, comparisons of J&J to the more similar Pfizer and Moderna may explain the three-vaccine choice results. That the pleasure of choosing between Pfizer and Moderna was supported in Study 1 but not Study 2 may have been due to the increased familiarity of the vaccines. Neither vaccine was authorized at the beginning of Study 1; both had emergency use authorization by Study 2, and people had about six months of experience with them. As a result, we speculate that people knew how similar they were in efficacy and side effects; choices between two similar items, when you do not care which one you get, may not produce the pleasure that other choices do.

Study 1's attention-splitting results—but not Study 2's—indicated that informing people about options on the market in the absence of choice can backfire, counter to economic theory (Lancaster, 1990). This result is consistent with a meta-analysis of choice-overload effects with low choice-set complexity or easy tasks (McShane & Böckenholt, 2018). Study 1—conducted amid the first COVID-19 vaccine receiving emergency use authorization and with more information about the vaccines than usual due to Operation Warp Speed—revealed that vaccine likelihoods were higher when shown one than two vaccines. If the public had been fully informed about the vaccines due to their well-publicized press releases, such effects would not have emerged. Instead, presenting two vaccines may decrease the attention paid and subsequent affect towards any single vaccine similar to prior studies (e.g., Fenske & Raymond, 2006), thus decreasing vaccine likelihood. Study 1's attention-splitting effect, however, was not explained by affect as its mediating mechanism. Additionally, Study 2 garnered no support for this hypothesis. The effect therefore may depend on having little difference between vaccines (Study 1 tested similar Pfizer and Moderna vaccines), or it may be stronger with novel stimuli. Evaluability H2 went unsupported across studies.

The present results may be more generalizable due to their conduct in a more natural environment where participants differed in their knowledge and familiarity with the vaccines. However, doing so also may have introduced between-study differences in the effects obtained. Powerful effects of within-study differences in knowledge and familiarity seem less likely given that we controlled for demographic differences (race, age, gender, and education) and existing attitudes (ideology and a priori vaccine likelihood) in all analyses. Additionally, effect sizes for pleasure-of-choice findings were similar in Studies 1 and 2, η_p^2=.02, despite them being conducted at different timepoints in the vaccine rollout (December 2020 and June 2021). Finally, the fact that Study 1a—conducted between Studies 1 and 2—included less information and did not demonstrate the same pleasure-of-choice effect supports the notion that comparisons and/or elaborative processing of provided information—rather than knowledge retrieval processes—may be needed for pleasure-of-choice effects to emerge.

Research conducted in more applied COVID settings cannot be replicated. Thus, future research should assess knowledge and familiarity with vaccines and/or experiment with novel hypothetical vaccines to control learning and familiarity. It should also randomize the order in which vaccines were described given that order could have contributed to some results, perhaps especially in Study 1 with Pfizer described fully before Moderna.

The present manipulations and especially the potential benefits of having choice also should be tested in the natural world to ascertain actual vaccine uptake and especially among underserved populations such as racial and ethnic minorities, people working essential jobs, and immigrants/refugees who have lower COVID-19 vaccination and testing rates compared to their counterparts. In COVID-19, people may have empowered themselves with choice, locating pharmacies and other vaccine sites that advertise their preferred vaccine brand. However, not

everyone has the time, knowledge, and resources to do so, introducing an ethical issue.

Conclusion

The COVID-19 pandemic presented an unusual public-health situation with multiple, branded vaccines emerging faster than anticipated and with the public having more-than-usual access to vaccine information. The pleasure-of-choice results point towards the possibility that vaccine and vaccine-booster likelihoods can be increased among unvaccinated and vaccinated Americans by allowing choice. If choice is not allowed, presenting information about only one vaccine may be beneficial to uptake, but results were mixed. The present effects also were small (for pleasure-of-choice, η_p^2=.02-.03 where η_p^2=0.01 and 0.06 indicate small- and medium-effects, respectively). Thus, these manipulations cannot be the only solution. Increasing vaccination rates will require attacking the problem from multiple angles, similar to coordinated public-health efforts to reduce cigarette smoking (Peters & Shoots-Reinhard, 2018). Nonetheless, highlighting the pleasure of choice may be a simple, albeit partial, solution in vaccinated and unvaccinated populations to fighting diseases when multiple vaccines exist.

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Figure captions

Figure 1. Effects of the number of vaccines described on intentions and affect (both on 1-6 scales) in the absence of choice. Estimated marginal means are reported; error bars indicate standard errors of the estimated marginal means. Covariates are held at their mean level; effects of covariates appear in **Tables S4**, **S8**, and **S11**.

Figure 2. Effects of the presence *vs* absence of choice in multiple vaccine conditions. Estimated marginal means are reported; error bars indicate standard errors of the estimated marginal means. Covariates are held at their mean level; effects of covariates appear in **Tables S5**, **S9**, and **S12**.

Figure 3. Study 2 side-effect information for the three vaccines. Likelihood information was from CDC webpages and based on the first (or only) shot received (CDC, 2021, 2022a, 2022b). All three CDC websites are in the public domain.