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Article

Pro-Vaccination Flu and COVID-19 Messages: Evidence of Congenial Targeted and Spillover Effects †

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Abstract: Given the plentitude of messages in the public arena that promote vaccination against different diseases or raise the possibility of vaccine mandates, we asked whether message effects in one disease domain might spill over into other domains. Our experiment exposed individuals (N = 1755) recruited from an opt-in online panel (Qualtrics) on influenza or COVID-19 pro-vaccination messages then measured intentions to vaccinate for each disease and intentions to support a vaccine mandate for each disease. Messages that targeted flu (vs. COVID-19) exhibited stronger effects on intentions to vaccinate for corresponding (vs. noncorresponding) disease. We observed positive spillover from intention to vaccinate against one disease to intention to vaccinate against the other disease, as well as from vaccination intention type to support for corresponding and noncorresponding vaccine mandates. Although pro-vaccination flu and COVID-19 messages have multiple effects, those effects are congenial. The results adjudicate differences in spillover theory and suggest synergistic effects between pro-vaccination campaigns.

Keywords: pro-vaccination messages; mandate; COVID-19; influenza; spillover effects

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1. Introduction

By reducing morbidity and mortality, vaccines have had a dramatic and favorable effect on human health [1]. Yet, success in the realm of vaccine development has been constrained by human behavior. Simply put, the availability of a vaccine is insufficient to ensure that individuals will be vaccinated. The term *vaccine hesitancy* is commonly used to describe individuals who have access to a vaccine but, by choice, have not received it [2]. In 2019, the World Health Organization declared vaccine hesitancy to be one of the top ten threats to global health.

Among the array of tools for overcoming vaccine hesitancy, two were of special interest: messaging and mandates. For example, persuasive campaigns encouraged vaccine uptake for COVID-19 once a vaccine was available. The promotion of flu vaccinations is a seasonal event. With respect to mandates, in the United States, all states require children to be vaccinated against certain diseases as a condition of school attendance [3]. During the pandemic, the possibility of a COVID-19 vaccine mandate was part of the national discourse in the United States [4]. Members of the Society for Healthcare Epidemiology proposed that an annual flu vaccination should be a condition of employment for healthcare workers [5].

Given a reality in which multiple diseases threaten human well-being and multiple solutions exist for combatting those threats, it seems reasonable to consider how these factors may impinge upon one another. Does the persuasive impact of an influenza vaccine message have favorable or unfavorable implications for acceptance of a COVID-19 vaccine message? Might messages that encourage choiceful vaccine uptake also underwrite change in support for vaccine mandates? Or could they undermine one another? To address these issues, we conducted an experiment that exposed individuals to messages that encouraged uptake of influenza and COVID-19 vaccines, then measured intentions to be vaccinated and support for mandates for both disease topics. Before describing the experiment and its results, we provide a theoretical background for the project overall.

2. Targeted and Spillover Message Effects

Traditionally, persuasion research has focused on the question of how a message concerned with behavior *X* might influence recipients' position on that same issue. Does a message that advocates for obtaining a flu vaccination increase the chances that an individual will actually receive the shot? To the extent that a message produces a change in the targeted attitude, intention, or behavior, it is said to have had a *targeted effect* (see path A in Figure 1). From this observation, it is intuitive that a persuasive message aimed at any specific behavior (e.g., *X*) is likely to have a greater impact on the intention to do *X* than on the intention to do *Y*. Although we are unaware of any study that has explicitly tested this prediction, the data patterns reported in previous research [6,7] are consistent with it. Given the context of this investigation, we asked the following research question:

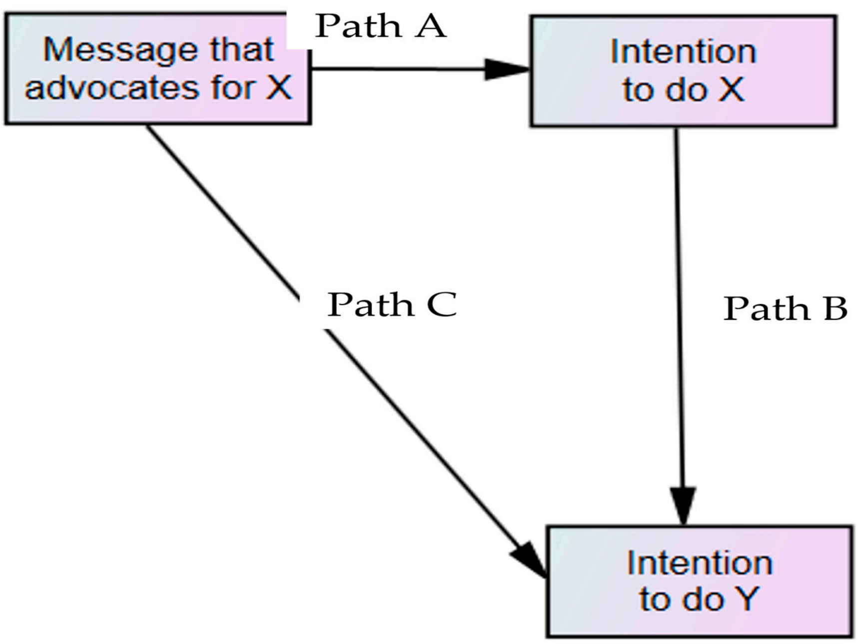

Figure 1. Target (A) and spillover (A + B and C) effects.

RQ1. *Does exposure to a flu (COVID-19) pro-vaccination message yield a greater impact on the likelihood of obtaining the corresponding versus non-corresponding vaccination?*

Much less research has been devoted to the possibility that a message advocating change in the target issue *X* can modify some non-target issue *Y* (see [6,7]). Such changes are possible because every attitude or intention resides in a cognitive structure composed of related attitudes and intentions [8,9]. Change in one element may have logical implications for one or more of the other elements that comprise the structure. The associative network model of memory [10] has a similar conceptualization: Memory is a network of cognitive concepts that are interconnected by links that indicate the strength of association between the concepts. For example, the concepts of knives, forks, and spoons are linked because they are instances of flatware, because they have similar functions, and because they co-occur during meals. The concepts of the COVID-19 vaccine and the flu vaccine might be associated because they are both vaccines with similar functions and a common method of delivery, as well as the type of diseases that the vaccines are expected to prevent (i.e., infectious diseases that impact the respiratory tract). When a concept is activated in memory, related concepts in its associative network will be simultaneously activated, the degree of which is a function of the strength of their association in the network.

Positive spillover is said to occur when a change in Y aligns with a message that advocates change in X. For instance, an increased willingness to obtain a flu vaccination might have implications for willingness to obtain a COVID-19 vaccination. Positive spillover is thought to be the product of consistency processes, including the desire to avoid the discomfort that follows from holding two inconsistent cognitions (i.e., dissonance) or the self-inferences drawn from observing one's own behavior (i.e., self-perception; [11]). The co-activation processes in the associative network theory of memory posit similar effects. *Negative spillover* is present when the change runs counter to the advocacy of the message. This pattern has been attributed to decrements in the resources needed for conscious decision making (i.e., ego depletion) or the belief that doing one good act amounts to permission to do one bad act (i.e., moral licensing; [11]). The inhibitory processes in the associative network of memory (in which the number and relevance of concepts activated simultaneously are controlled or limited) would imply negative spillover effects or a lack of spillover effects.

Conceptualizing spillover in terms of non-targeted change is valuable in that it sensitizes researchers to the possibility that messages may produce effects beyond those of the message advocacy. Yet, it glosses over the fact that spillover may take two distinct forms. One is that change in issue Y is mediated by change in issue X (see path B in Figure 1). This is an *indirect effect* [12]. For instance, after exposure to the pro-flu-vaccination message, individuals might decide to obtain a flu vaccination (issue X), then reason that many of the same justifications for the flu shot also apply to a COVID-19 vaccine and, on the basis of those reasons, decide to seek out a COVID-19 vaccination (issue Y). In this case, a change in the target attitude is the cause of the change in a non-target attitude.

Attitude structures or associative memory networks, however, can be complex ([10] pp. 8–9). It is always possible that some of the elements of any given structure are unknown to researchers and, consequently, go unmeasured (e.g., Z). Under such circumstances, a message effect on Y might be present without any observable change in X. The indirect pathway through concept Z is not manifest because Z has not been measured. Consequently, all that the research can show is what appears to be a direct message effect on non-targeted issue Y (path C in Figure 1). The presence of a path-C-type association forces the conclusion that pertinent elements of the attitude structure have not been identified. This, in turn, points to the need for better theory and/or more comprehensive formative research.

In the case of flu or COVID-19 vaccinations, it is obvious that each of these two vaccine types might have implications for the other. Positive spillover might be expected to the extent that vaccinations of either sort are viewed favorably. However, among persons who evaluate the flu and COVID-19 vaccines differently, negative or no spillover might be expected. Additionally, there is evidence that substantial numbers of Americans are uncertain about the safety of the COVID-19 vaccine because its means of production (i.e., mRNA) is novel (e.g., [13,14]). Given these possibilities, we asked the following research question:

RQ2. *Do the effects (if any) of exposure to a flu or COVID-19 pro-vaccination message produce spillover (positive or negative, direct or indirect) onto the likelihood of obtaining the non-corresponding vaccination?*

Vaccine mandates have been an important policy-level tool for creating herd immunity and protecting public health. They are not, however, uniformly accepted. Indeed, there has been resistance to vaccine mandates for as long as vaccines have existed [1]. Efforts to implement a COVID-19 vaccine mandate were especially contentious, with opponents characterizing those efforts as governmental overreach and an unequivocal intrusion on personal freedom [15]. Nonetheless, mandates remain a topic of discussion in the national discourse, and they are the policy-level concept that corresponds most closely to the individual-level decision to vaccinate or not. Consequently, mandates represent a potentially important element in cognitive structures related to vaccines. Accordingly, we were curious as to the potential of flu and COVID-19 pro-vaccine messages to cause indirect effects on intentions to endorse mandates.

RQ3. *To what extent, if any, do flu or COVID-19 vaccine intentions produce spillover (either positive or negative) onto the likelihood of endorsing (a) corresponding or (b) non-corresponding vaccine mandates?*

3. Audience Factors Associated with Vaccine Hesitancy

3.1. Political Orientation

There is good reason to believe that resistance to vaccine uptake is, at least in part, a product of political identity [16,17]. Both before and after his election, Donald Trump promoted anti-vaccination conspiracies [18], was dismissive of the effects of COVID-19, and encouraged members of the public to view vaccinations and mask mandates as attacks on their individual liberties [19]. Subsequently, Republicans and right-wing media outlets downplayed the threat of COVID-19 and opposed public health efforts to impede its spread [20]. There is also evidence that Republicans and conservative individuals are more prone to COVID-19-related conspiracy theories than Democrats and liberal individuals [21]. With respect to vaccine hesitancy and its possible causes, Fridman et al. [22] note that "political orientation explains more variance than any other socio-demographic variable" (p. 3). Given all of this evidence, we expected that

H1. *Conservative political orientation is negatively associated with intentions to vaccinate.*

3.2. Prior Behavior

Although exceptions certainly exist, past behavior is generally a strong predictor of future behavior [23]. One explanation for this well-established fact is that the same set of personal and social factors that shaped decision making at the earlier point in time are typically present and active at the subsequent point in time [24]. In addition, individuals at a later time are aware of their earlier actions, which induce commitment and a desire to maintain consistency [25]. For these reasons, it was expected that

H2. *Previous vaccination behavior is positively associated with intention to vaccinate.*

4. Method

Participants and Procedure

Data collection took place during the fall of 2022. Participants were sampled from the general U.S. population recruited through a national, compensated opt-in online panel comprised of individuals registered with Qualtrics. Screening demographic questions ensured that the sample matched the U.S. population in terms of age, gender, race/ethnicity, education, income, and the region of the country where they reside.

In addition to demographic items, consenting participants responded to questions about their vaccination history (COVID-19 and influenza), risk perception related to COVID-19 and influenza, and political orientation before they were randomly assigned to either the topic of COVID-19 or influenza vaccine. Toward the end of the questionnaire, participants reported their intention to receive annual COVID-19 re-vaccination (if recommended) or the influenza vaccine.

To improve data quality, respondents were dropped if they (a) failed attention-check questions, (b) took less than 6 min (min = 6.53, max = 101 min, M = 17.70 min, SD = 8.75 min) to complete the survey, or (c) engaged in straight-lining. Table 1 summarizes the features of the final sample (N = 1755).

Table 1. Demographic characteristics of the sample.

	***N* = 1756**	
	n	**%**
Gender		
Male	877	49.9%
Female	843	48.0%
Non-binary	36	2.1%
Race		
White	1312	74.7%
Black/African American	220	12.5%
Hispanic/Latino	100	5.7%
Asian or Pacific Islander	102	5.8%
American Indian or Alaskan Native	16	0.9%
Other/Prefer not to answer	7	0.4%
Geographic area		
Urban	518	29.5%
Suburban	901	48.7%
Rural	337	19.2%
Household annual income		
Less than $25,000	290	16.5%
$25,000–$49,999	434	24.7%
$50,000–$99,999	578	32.9%
$100,000–$149,999	298	17.0%
$150,000 and above	156	8.9%
Education		
Less than high school	20	1.1%
High school diploma or equivalent	489	27.8%
Associate degree	287	16.3%
Bachelor's degree	649	37.0%
Master's degree	244	13.9%
Doctoral or professional degree	67	3.8%
	M	*SD*
Age	44.57	15.46

After accessing the survey, participants provided background information on a variety of sociodemographic indices (see Table 1). Then, they viewed two messages (out of a total of four and presented in a random order), both of which advocated for either a flu vaccination (N = 879) or a COVID-19 vaccination (N = 876). The order of presentation was determined by random assignment. Immediately following exposure to both messages, participants provided information about their intention to be vaccinated for flu and COVID-19, as well as the likelihood that they would support a vaccine mandate for each of the two diseases.

5. Measures

5.1. Political Orientation

This variable was measured via two 7-point semantic differential items: liberal/conservative and left-wing/right-wing. A composite score was created by taking the average of the two items (r = 0.86), where higher scores indicate a stronger conservative position.

5.2. Prior Vaccination Behavior

For COVID-19 vaccination behavior, participants were asked to report (yes/no) if they have received the updated COVID-19 booster shot, the first booster shot, the primary series (i.e., two doses of the Pfizer or Moderna vaccines or a single shot of the Johnson & Johnson vaccine), or no vaccines. For influenza vaccination behavior, participants were asked to report if they had received the influenza vaccine for the 2022–2023 flu season.

5.3. Vaccination Intention

On a 0–100 scale (0% = *not likely at all*, 100% = *absolutely*), participants indicated on a slider either their likelihood of receiving annual re-vaccination for COVID-19 if it is recommended by the CDC or the influenza vaccine for the current flu season (if they had not received the vaccine yet) or the next flu season (if they had received the vaccine for this year).

5.4. Message Type and Topic

Message topic was defined in accordance with vaccine type, that is, flu versus COVID-19. Four types of animated video messages were developed for each topic. The first focused on vaccine effectiveness; the second was concerned with vaccine-related misinformation; the third message type concerned itself with the side effects of vaccines; and the fourth type took the perspective of other-benefiting (synopses of the messages are available in the Supplementary Materials).

Cell-to-cell comparisons of the intention to vaccinate were conducted within topic using linear mixed models. None of these comparisons was statistically significant ($p = 0.37$ for COVID-19 and $p = 0.95$ for flu). Table 2 presents the marginal means and standard errors for intention to vaccinate within each topic. Accordingly, we collapsed across types, which produced a binary index of message topic. For use in subsequent analyses, we set flu = +1 and COVID-19 = −1.

Table 2. Means and standard errors for intention to vaccinate by message topic and type.

	Topic: Influenza	
Message Type	**Mean**	**Standard Error**
Vaccine Effectiveness	56.10	1.91
Side Effects	56.22	1.93
Misinformation	57.58	1.95
Other-Benefiting	56.75	1.93
	Topic: COVID-19	
Message Type	Mean	Standard Error
Vaccine Effectiveness	54.93	2.00
Side Effects	59.00	1.99
Misinformation	57.38	2.03
Other-Benefiting	54.76	2.03

5.5. Missing Data

Because missing data comprised a small fraction of 1% of the data points, mean substitution was used to impute the values. Although this approach is negatively biased, the bias cannot be larger than the overall quantity of missing data. Given such a small value, bias was not a concern.

5.6. Analysis

The research questions and hypotheses were evaluated via structural equation modeling. This technique was chosen because it was well suited to the analysis of causal relationships in a multi-variable conceptual space. Using AMOS v29, we tested a series of models using maximum likelihood estimation. The starting point in this process was the most parsimonious model that included both direct and spillover effects. This is illustrated in Figure 2, which shows direct message effects within message topic only and spillover effects onto support for mandates also within topic only. As shown by the use of variable names within boxes, each of the variables was treated as manifest. This followed from the fact that our measures were single-item. Exogenous variables were allowed to correlate with one another, but (initially) errors of prediction were not.

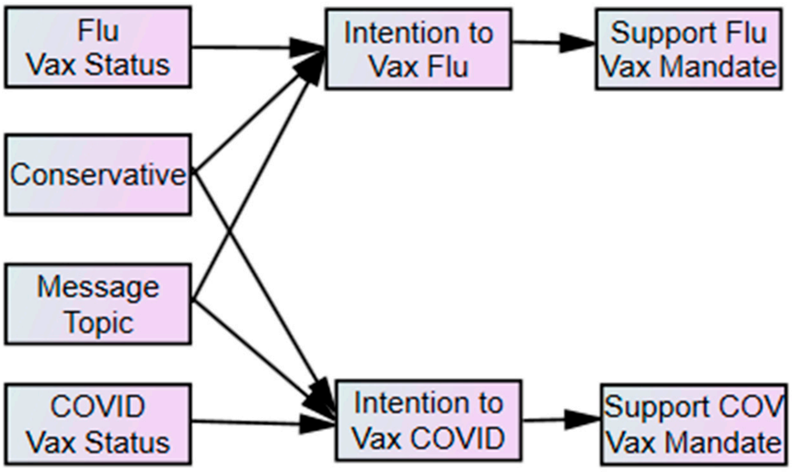

Figure 2. Base model: direct message effects and topic specific spillover with audience factors.

Absolute model fit was assessed using Hu and Bentler's [26,27] recommended guidelines for the Tucker–Lewis Index (TLI) > 0.949, root mean squared error of approximation (RMSEA) < 0.08, the probability of close fit, PCLOSE > 0.05, and the standardized root mean residual (SRMR) < 0.08 [26,27]. We report χ^2 but gave its associated significance test little attention given its sensitivity to sample size. Model comparisons were evaluated with respect to change in χ^2 and change in the Bayesian Information Criterion (BICΔ). Raftery [28] suggests that BIC differences in the 0–2 range should be considered weak evidence that one model is superior to the other. Differences in the 2–6 range are "positive evidence", 6–10 are "strong evidence", and values larger than 10 are "very strong" (p. 139).

6. Results

Data reported here are part of a larger project. Not all variables were used in the analyses reported here. The data files used, and message synopses are available at: https://doi.org/10.17605/OSF.IO/WPQ34 (accessed on 8 February 2024).

6.1. Model Fitting

As evidenced by the first row of Table 3, the model in Figure 2 showed a poor fit to the data. None of the fit indices were even close to acceptable. Model 2, which added reciprocal paths (models were modified one path at a time; for the sake of brevity, however, we report only the model in which both paths were added) from flu vaccine intention to COVID-19 vaccine intention, showed improvement, but the fit statistics were still far from satisfactory. Model 3 included paths that emanated from each vaccine intention to the noncorresponding mandate (i.e., from flu intention to COVID-19 mandate and from COVID-19 intention to flu mandate). This change improved fit: however, still, none of the indices were within acceptable limits. Inspection of the modification indices revealed that fit could be substantially improved by allowing a path from flu mandate to COVID-19 mandate and from COVID-19 mandate to flu mandate. Doing so, however, would yield an unidentified model. Hence, we allowed a bidirectional association between the error terms for the two mandates. Conceptually, this change can be understood as recognition that there are variables or relationships that are not explicitly modeled. The results for Model 4 showed a good absolute fit on all indices and a huge BICΔ. The stability index for the non-recursive relationship between the vaccine intention measures was 0.114, a value well below 1 and therefore of no concern [29].

Table 3. Fit statistics for structural equation models.

Model Number and Structure	χ^2 (d.f.)	TLI	RMSEA [90% CI]	Close Fit *p*	SRMR	BIC	BICΔ [a]
1. Figure 2	2699.16 (14) ***	0.385	0.331 [0.320/0.341]	0.000	0.163	2863.50	--
2. +reciprocal paths between vaccine intentions	1759.22 (12) ***	0.533	0.288 [0.277/0.300]	0.000	0.087	1938.50	925.00
3. +crossover paths from vaccine intentions to support for mandates	1594.35 (10) ***	0.492	0.301 [0.288/0.313]	0.000	0.060	1788.58	149.92
4. +e2 ← →e4	57.68 (9) ***	0.983	0.056 [0.042/0.070]	0.232	0.020	259.37	1529.21
5. +message topic → flu mandate	46.40 (8) ***	0.985	0.052 [0.038/0.067]	0.368	0.019	255.56	3.81
6. +conservative → both mandates = final obtained model	10.93 (6)	0.997	0.022 [0.000/0.042]	0.993	0.005	235.03	16.81
7. alternative: vaccine intentions switch places with mandates	941.66 (6) ***	0.500	0.298 [0.282/0.314]	0.000	0.090	1165.77	−930.74
8. alternative: vaccine intentions and mandate intentions are latent variables	1077.75 (13) ***	0.738	0.216 [0.205/0.227]	0.000	0.050	1249.57	−1014.54

[a] Preceding BIC value minus succeeding BIC value, except Model 8, which is compared to Model 6. *** $p < 0.001$.

Although the foregoing results could justify accepting Model 4, we explored the potential for better-fitting models. Inspection of the modification indices revealed that fit could be further enhanced with the addition of a direct path from message topic to flu mandate; the χ^2 difference between Models 4 and 5 was 11.28 (1), $p < 0.001$) and the BICΔ was 3.81 (i.e., "positive evidence", [28] (p. 139)). Modification indices showed that adding paths from conservative political orientation to the flu and COVID-19 mandates would improve fit (as before, paths were put in one at a time. In each case, modifications indices called for adding the other path; to conserve space, results are reported only for the model with both paths). Given compelling theory and evidence from earlier work, this change was justified. The resulting Model 6 showed an excellent fit to the data on all indices; even the χ^2 was nonsignificant. Stability values remained unchanged at 0.114 (as they should be, given that there were no changes to this portion of the model). In light of (a) overall fit, (b) the fact that parameter estimates did not differ much from Model 4, and (c) there is a plausible argument that the differences in parameter estimates were more accurate for Model 6, we elected to interpret this set of results (summarized graphically in Figure 3).

6.2. Alternative Models

Although model fit statistics are informative with respect to the ability of a particular model to reproduce the data structure, it is possible that many other models fit the data equally well [30]. Due to our interest in estimating causal relationships among variables in an interconnected cognitive structure, we thought it valuable to consider the viability of other causal flows. To this end, Model 7 flipped, within message topic, the location of the intention to vaccinate for flu (COVID-19) and support for a mandate for flu (COVID-19). Fit statistics for the model, given in the bottom-most row of Table 3, far exceeded the guidelines recommended by Hu and Bentler [26,27]. It was not possible to compute an χ^2 difference because Model 7 was not nested within Model 6, but the BICΔ difference of −930.74 strongly favored Model 6. The two largest modification indices suggested the addition of paths from flu vaccination status to flu vaccination intentions and from COVID-19 vaccination status to COVID-19 vaccination intentions. These results indicate that the causal ordering of our endogenous variables is superior to the alternative, reversed ordering.

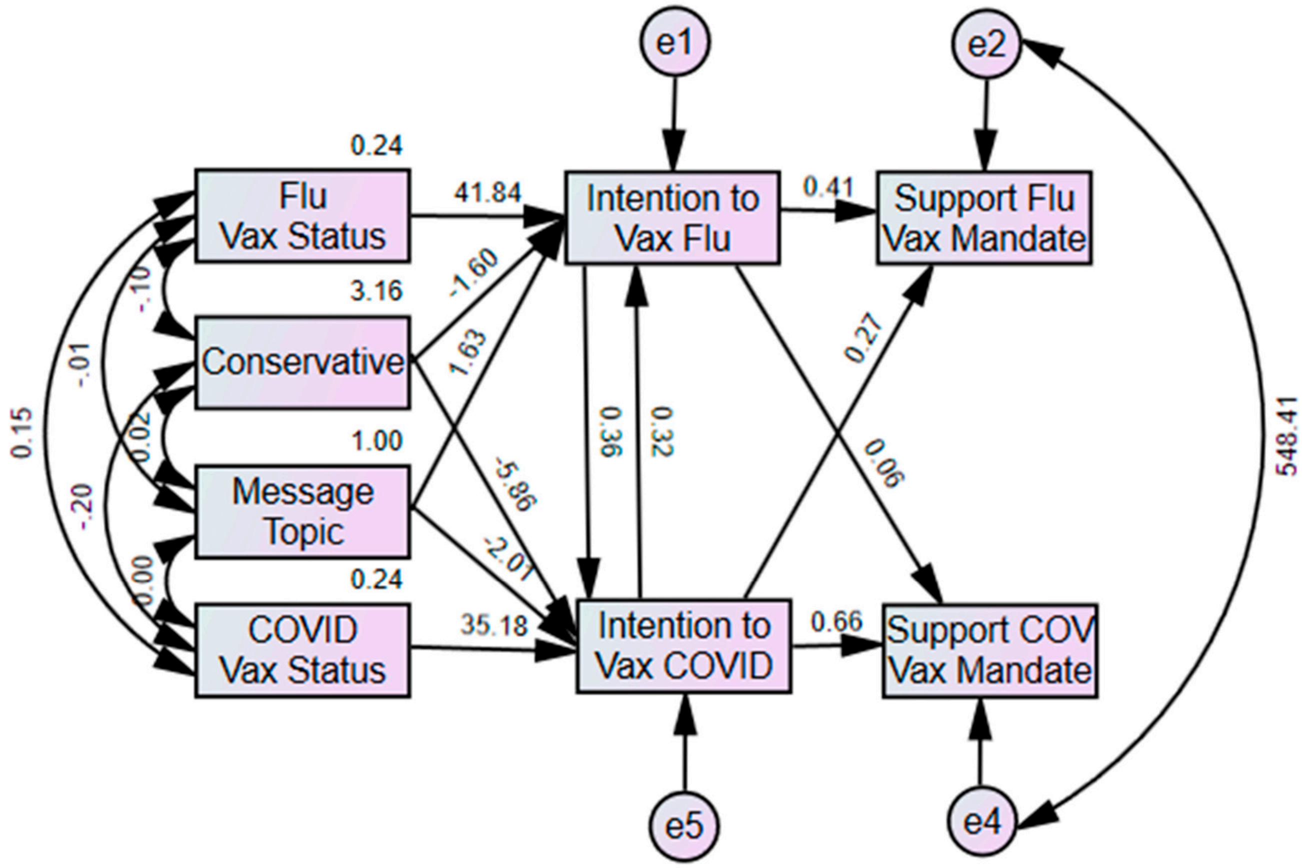

Figure 3. Obtained M=model. *Note.* Parameters are unstandardized. All causal paths are significant at $p = 0.008$ or less. For clarity, three paths are not shown: message topic (flu = 1, COVID-19 = −1) → support for a flu vaccination mandate ($b = 1.46$), conservative → flu mandate ($b = -2.07$), and conservative → COVID-19 mandate ($b = -2.29$).

A second alternative model treated the two vaccination intention measures as indicators of a latent, general predisposition to vaccinate, and the two mandate intention measures as indicators of a latent, general predisposition to support mandates. All four exogenous variables (Figure 2) had direct paths to the latent vaccination variable and no causal paths to any other variables. This model was compared to Model 6, the final obtained model. Here too, it was not possible to compute a χ^2 difference, but the BICΔ difference of -1014.54 strongly favored Model 6. The largest modification indices for directional paths showed a misfit that was the result of constraining associations between flu or COVID-19 vaccination status to within-disease intentions or their error terms. Collectively, these findings undermine the plausibility of a latent factors model and, by implication, affirm an approach that maintains the disease domains as conceptually distinct from one another. None of the results for the two alternative models guarantee that Model 6 is the correct model. They do, however, provide evidence that our representations of causal ordering are superior to the alternative and that our treatment of disease domains is superior to the alternative. With this added confidence in the veracity of our model, we turned to an evaluation of the research questions and hypotheses.

6.3. Research Questions: Targeted and Spillover Message Effects

RQ1 asked whether exposure to a flu (COVID-19) pro-vaccination message would yield a greater impact on the likelihood of obtaining the corresponding versus non-corresponding vaccination. An answer to this question can be found by considering the effect of the message topic contrast variable on intent to obtain a flu vaccination ($b = 1.62$, $p = 0.006$) and on intent to obtain a COVID-19 vaccination ($b = -2.01$, $p < 0.0001$). Both coefficients indicate that the advocacy of the message had a stronger impact on the corresponding vaccination intention than on the noncorresponding intention. It is worth noting, however, that the effects were relatively small, with exposure to one topic producing only a 1.6–2% difference over the other topic.

The second RQ concerned itself with whether the effects of exposure to a flu or COVID-19 pro-vaccination message would spill over onto the self-reported likelihood of obtaining the non-corresponding vaccination. As shown in Figure 3, there are no direct paths from either vaccination message to the noncorresponding vaccination, which is an indication that the data showed no association. That is, there was no evidence of direct spillover. However, the coefficient representing the effect of flu vaccination on COVID-19 vaccination was $b = 0.36$ ($p < 0.0001$). The parallel coefficient for COVID-19 to flu was $b = 0.32$ ($p < 0.0001$). Coupled with the findings for message exposure (i.e., RQ1), these results may be seen as evidence of indirect spillover (cf., paths A and B of Figure 1). The sign of the two coefficients indicates that the direction of spillover is positive.

RQ3 asked the following question: to what extent, if any, do flu or COVID-19 vaccine intentions produce spillover onto the likelihood of endorsing (a) corresponding or (b) non-corresponding vaccine mandates? The issue of spillover within message topics can be seen in the flu intention → flu mandate coefficient ($b = 0.41$, $p < 0.0001$) and in the COVID-19 intention to COVID-19 mandate coefficient ($b = 0.66$, $p < 0.0001$). Both indicate positive spillover. Cross-topic spillover can be assessed by considering the flu intention → COVID-19 mandate coefficient ($b = 0.06$, $p < 0.008$) and the COVID-19 intention to flu mandate coefficient ($b = 0.27$, $p < 0.0001$). Both indicate positive spillover.

6.4. Audience Factors

The first hypothesis predicted a negative association between conservative political orientation and intentions to vaccinate. The negative coefficients for intention to vaccinate against the flu ($b = -1.60$, $p < 0.0001$) and COVID-19 ($b = -5.86$, $p < 0.0001$) indicated support for the prediction. Conservative political orientation also showed unanticipated associations with support for a flu mandate ($b = -2.07$, $p < 0.0001$) and a COVID-19 mandate ($b = -2.29$, $p < 0.0001$)

H2 anticipated that previous vaccination behavior would be positively associated with intention to vaccinate. Coefficients for flu and COVID-19, respectively were $b = 41.84$ and $b = 35.18$, both $p < 0.0001$. The hypothesis was therefore supported.

7. Discussion

It might be said that the vaccine message environment is dense. There are many appeals that encourage individuals to seek vaccination for the flu and COVID-19. In the news media and the national discourse, there is also discussion of mandates for either or both viruses. Assuming awareness of these issues in the general population, it is important to understand whether they amplify or attenuate one another. This project sought to model the targeted and spillover effects of flu and COVID-19 pro-vaccination messages on intentions to vaccinate and support for mandates.

7.1. Targeted Message Effects

We explicitly tested the notion that the target of a persuasive appeal would have a greater impact on its corresponding intention than on a different intention. The results showed that the effect of a flu (COVID-19) vaccine message was greater on flu (COVID-19) intentions to vaccinate than the reverse. Although this prediction may seem obvious, there are many instances in which the opposite seems to have occurred. In one experiment, participants read arguments (ostensibly) created by minority persons that advocated for the exclusion of gay men from the U.S. military [31]. Participants did not change their position on that issue, but they did alter their stance on the prohibition of firearms. In the same vein, when exposed to messages that described the dangers associated with overconsumption of sugar-sweetened beverages, respondents who identified as non-drinkers mostly did not change their position on consumption (a small number decided to increase their consumption from none to some) [32]. They did, however, become more favorable toward policies that would restrict access to those beverages. Hence, as commonsensical as it may seem, the persuasive superiority of a topically relevant message is not ensured.

It is worth noting that the relative impact of topical focus was small in this study, such that exposure to one vaccine topic produced only a 1.6–2% difference over the other topic. One interpretation of these effect sizes is that the concepts are proximal to one another in conceptual space. This follows from studies showing that the persuasive impact of a message spreads outward from the target concept such that it shows the greatest change, medially related objects show moderate change, and distally related objects show the least change [6,33]. While we find this interpretation plausible, it is speculative; our study did not include any independent measures of the distances between concepts. In our view, a conceptual mapping of disease domains could prove quite valuable to future investigations of pro-vaccination messages.

7.2. Spillover Effects: From Individual Decisions to Policy Preferences

The data revealed three sorts of spillover effects. The first was seen in the effect of intention to vaccinate on intention to support a mandate (cf., path B in Figure 1). For the flu, a 1% difference in vaccination intention was associated with a 0.41% difference in mandate support. The corresponding figure for COVID-19 was 0.66%. As suggested above, these sizeable coefficients may be indicative of tight cognitive linkages between the two actions.

The second type of spillover appeared in the effect of vaccine intention on support for the non-corresponding mandate. For the flu, a 1% difference in vaccination intention was associated with a 0.06% difference in support for a mandated COVID-19 vaccination. For COVID-19, the association was 0.27%. Although both effects are smaller than those discussed in the previous paragraph, both are also positive and statistically significant. These are instances of Path-B-type effects (Figure 1) but with different and, presumably, more conceptually distant concepts.

Third, the message topic contrast offered evidence of a Path-C-type spillover effect, as seen in the direct path from messages that argued for vaccination to support a flu mandate. The effect size means that exposure to a flu message corresponded with positive support for a flu mandate that is 1.46% greater than exposure to a COVID-19 vaccination message.

These findings have interesting implications for theories of spillover. To wit, hierarchical models posit the existence of logical structures composed of concepts that vary in level of abstraction. As a category, *health threats* encompass subordinate concepts such as threats from communicable and non-communicable diseases. The category of *communicable diseases* encompasses the subordinate concepts of influenza and COVID-19. In such structures, message-induced change at superordinate levels has implications for change at subordinate levels because the lower levels are logically subsumed by the higher levels [34]. Thus, downward spillover is possible.

Our results, however, align more closely with multidimensional models of attitude structure and allow for spillover in all directions [12,35]: top-down, bottom-up, or lateral. Our results clearly show lateral change in that intentions to vaccinate against the flu showed a causal influence on intention to vaccinate against COVID-19 and vice versa (Figure 3). Additionally, if we conceive of vaccinations and mandates as elements in a category labeled *Actions to Take Against Threats from Disease*, we see further evidence of lateral change. In our data, differences in vaccination intentions for one disease were associated with differences in support for mandated vaccination for the non-corresponding disease. This implies that the basic assumption of hierarchical theories of spillover is untenable.

7.3. Audience Factors Associated with Vaccine Hesitancy

Inclusion of the audience factors—political orientation and prior vaccination behavior—served two functions. For one, they operated as control variables in analyses that were the primary motivation for this project, that is, understanding targeted and spillover effects. However, they are also of interest in their own right given evidence that they play an important role in efforts to promote vaccine uptake.

7.4. Political Orientation

The results of the final model showed that political orientation was associated with greater hesitancy for both vaccines. For every one unit change toward the conservative end of the seven-point scale, intention to vaccinate was smaller by 1.60% for the flu and 5.86% for COVID-19. Political orientation was also associated with diminished support for mandates, at −2.07% for the flu and 2.29% for COVID-19 per unit change in political orientation. These results echo prior research findings insofar as they demonstrate a general aversion to vaccination, both at the level of individual choice and policy preference (e.g., [16,17]). Our results are novel in that they allow a direct, quantitative comparison of the degree to which influenza and COVID-19 vaccinations and mandates are politicized.

7.5. Prior Behavior

As expected, prior behavior was a strong predictor of future behavior. Having had a flu vaccination in the past (vs. not) was associated with a 42% greater likelihood of obtaining one in the future. The figure for COVID-19 was 35%. Such values do show a notable tendency toward consistency over time, but they are also smaller than they might be. Indeed, they suggest that individuals are not merely slaves to the past; more than 50% of the likelihood of intending to be vaccinated can be attributed to factors other than prior behavior (e.g., intervention messages). We might reasonably conclude that this represents an opportunity for persuasive messaging that is designed to change behavior.

An important caveat to this line of thinking is that it applies only to those who reported having received one of the vaccinations. Persons who were not vaccinated against the flu were 58% less likely to do so in the future compared to prior vaccinators. The corresponding value for COVID-19 was 65%. Thus, it appears that in this case, the power of past action versus inaction is not equivalent in terms of effects on subsequent conduct; vaccine-resistant behavior is determined to a larger degree by previous hesitancy than vaccine acceptance is determined by previous acceptance. This, of course, implies that different sorts of persuasive messaging may be needed for the two groups—a topic that we take up next.

7.6. Implications for Reducing Flu- and COVID-19-Related Vaccine Hesitancy

The top-line applied finding of this project is that flu and COVID-19 messages exhibit congenial effects on one another in vaccine-hesitant persons. Or, stated more generally, communicable-disease-specific pro-vaccine messages are likely to amplify, rather than attenuate, the effects of persuasive messaging on different, but related, communicable disease topics. Assuming the desirability of high levels of vaccination in the general population, this top-line conclusion is good news for agents of change seeking to reduce vaccine hesitancy. It naturally leads to questions of message design and dissemination.

It seems apparent that differences in prior vaccine behavior call for different approaches to message design. Reinforcing established lines of action might succeed by ensuring that there are no barriers to the sought-after behavior (e.g., vaccine availability and reminding people of their past actions. In contrast, those who have declined vaccine uptake previously may be opposed to the notion of vaccination altogether and, therefore, require messages that arouse emotions or change estimates of disease severity and vaccine efficacy (cf., [36]). It is precisely because such beliefs are resistant to change that the results of this study are so promising. Evidence of positive spillover from flu to COVID-19 and vice versa suggests that more exposure to one type of message has the potential to exert a favorable influence in the noncorresponding disease domain. This implies the exciting possibility of simultaneous flu and COVID-19 vaccination campaigns to amplify the effects of one another. Of course, there are many questions as to how best to implement such a process. Should message dissemination occur such that campaigns have the same start dates, end dates, and with equal levels of media exposure? Are there levels of message exposure that would be fatiguing to recipients and therefore counterproductive? Would alternating topics each day/week/month reduce fatigue and thereby increase campaign effects? There are a multitude of possibilities here that would seem to warrant further examination of the effects of spillover and, especially the need for the development of theory that explicitly grapples with the temporal dynamics of spillover.

8. Strengths and Limitations

One positive feature of this investigation was the relatively large sample of U.S. residents that was matched to the population on several important sociodemographic dimensions. However, it was not a probability sample. Further, because our design did not include a no-message control group, the study speaks only to the relative impact of the messages on the two disease topics. The use of four messages within each topic, rather than one, avoided a case–category confounding and thereby enabled empirical claims concerning flu and COVID-19 messages more generally. A notable strength was the examination of both flu and COVID-19. This allowed direct comparisons between the two and permitted insights that would not have otherwise been possible (cf., [37]). Our study measured intentions to vaccinate, but not vaccination behavior itself. However, intention is an excellent predictor of behavior [38].

9. Conclusions

Spillover is the idea that messages focused on one persuasive target may have effects that ripple outward to related targets. This project showed such effects with regard to messages that advocated uptake of the flu and COVID-19 vaccinations; each message topic favorably influenced the other topic. Positive spillover was also observed with regard to mandates for each topic. In short, not only are flu and COVID-19 campaigns unlikely to harm one another, but our study shows that each can benefit from the other. These findings have important implications for spillover theory, and they underscore the need to explore message exposure on different disease topics that can be manipulated to create between-campaign synergies.

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References

1. Rees, A.R. *A New History of Vaccines for Infectious Diseases: Immunization-Chance and Necessity*; Academic Press: Cambridge, MA, USA, 2022. [CrossRef]
2. Galagali, P.M.; Kinikar, A.A.; Kumar, V.S. Vaccine hesitancy: Obstacles and challenges. *Curr. Pediatr. Rep.* **2022**, *10*, 241–248. [CrossRef]
3. Centers for Disease Control State School Immunization Requirements and Vaccine Exemption Laws. 2023. Available online: https://www.cdc.gov/phlp/publications/topic/vaccinationlaws.html (accessed on 5 March 2024).

4. Sorkin, A.R.; Karaian, J.; Kessler, S.; Gandel, S.; Hirsch, L.; Livni, E.; Schaverien, A. More vaccine mandates. *The New York Times*, 24 August 2021.
5. Donner, R.; Potirakis, S.; Balasis, G.; Eftaxias, K.; Kurths, J. Revised SHEA position paper: Influenza vaccination of healthcare personnel. *Phys. Chem. Earth* **2015**, *85–86*, 44–55. [CrossRef]
6. Cruz, S.M. Lateral attitude change on environmental issues: Implications for the climate change debate. *Clim. Chang.* **2019**, *156*, 151–169. [CrossRef]
7. Dinauer, L.D.; Fink, E.L. Interattitude structure and attitude dynamics. *Hum. Commun. Res.* **2005**, *31*, 1–32. [CrossRef]
8. Dalege, J.; Borsboom, D.; van Harreveld, F.; Berg, H.v.D.; Conner, M.; van der Maas, H.L.J. Toward a formalized account of attitudes: The causal attitude network (CAN) model. *Psychol. Rev.* **2016**, *123*, 2–22. [CrossRef]
9. Woelfel, J.D.; Fink, E.L. *The Measurement of Communication Processes: Galileo Theory and Method*; Cai, D.A., Ed.; Academic Press: New York, NY, USA, 1980; pp. 180–198.
10. Anderson, J.R.; Bower, G.H. *Human Associative Memory*; Psychology Press: London, UK, 1973.
11. Dolan, P.; Galizzi, M.M. Like ripples on a pond: Behavioral spillovers and their implications for research and policy. *J. Econ. Psychol.* **2015**, *47*, 1–16. [CrossRef]
12. Glaser, T.; Dickel, N.; Liersch, B.; Rees, J.; Süssenbach, P.; Bohner, G. Lateral attitude change. *Personal. Soc. Psychol. Rev.* **2015**, *19*, 257–276. [CrossRef]
13. Piltch-Loeb, R.; Harriman, N.W.; Healey, J.; Bonetti, M.; Toffolutti, V.; Testa, M.A.; Su, M.; Savoia, E. COVID-19 vaccine concerns about safety, effectiveness, and policies in the United States, Canada, Sweden, and Italy among unvaccinated individuals. *Vaccines* **2021**, *9*, 1138. [CrossRef]
14. Piltch-Loeb, R.; Savoia, E.; Goldberg, B.; Hughes, B.; Verhey, T.; Kayyem, J.; Miller-Idriss, C.; Testa, M. Examining the effect of information channel on COVID-19 vaccine acceptance. *PLoS ONE* **2021**, *16*, e0251095. [CrossRef]
15. Krugman, P. Unmasked: When Identity Politics Turns Deadly. New York Times. 4 March 2021. Available online: https://www.nytimes.com/2021/03/04/opinion/coronavirus-masks.html (accessed on 4 March 2024).
16. Albrecht, D. Vaccination, politics and COVID-19 impacts. *BMC Public Health* **2022**, *22*, 96. [CrossRef]
17. Donner, R.; Potirakis, S.; Balasis, G.; Eftaxias, K.; Kurths, J. Individual and social determinants of COVID-19 vaccine uptake. *BMC Public Health* **2015**, *21*, 818. [CrossRef]
18. Brown, B. Trump Twitter Archive. 2018. Available online: http://www.trumptwitterarchive.com (accessed on 4 March 2024).
19. Paz, C. All the President's Lies about the Coronavirus. 2 November 2020. Available online: https://www.theatlantic.com/politics/archive/2020/11/trumps-lies-about-coronavirus/608647/ (accessed on 4 March 2024).
20. Allcott, H.; Boxell, L.; Conway, J.; Gentzkow, M.; Thaler, M.; Yang, D. Polarization and public health: Partisan differences in social distancing during the coronavirus pandemic. *J. Public Econ.* **2020**, *191*, 104254. [CrossRef]
21. Enders, A.; Farhart, C.; Miller, J.; Uscinski, J.; Saunders, K.; Drochon, H. Are Republicans and conservatives more likely to believe conspiracy theories? *Politi. Behav.* **2022**, *45*, 2001–2024. [CrossRef]
22. Fridman, A.; Gershon, R.; Gneezy, A. COVID-19 and vaccine hesitancy: A longitudinal study. *PLoS ONE* **2021**, *16*, e0250123. [CrossRef]
23. Hagger, M.S.; Hamilton, K.; Phipps, D.J.; Protogerou, C.; Zhang, C.-Q.; Girelli, L.; Mallia, L.; Lucidi, F. Effects of habit and intention on behavior: Meta-analysis and test of key moderators. *Motiv. Sci.* **2023**, *9*, 73–94. [CrossRef]
24. Eagly, A.H.; Chaiken, S. *The Psychology of Attitudes*; Harcourt Brace: San Diego, CA, USA, 1993.
25. Albarracín, D.; Wyer, R.S., Jr. The cognitive impact of past behavior: Influences on beliefs, attitudes, and future behavioral decisions. *J. Pers. Soc. Psychol.* **2000**, *79*, 5–22. [CrossRef]
26. Hu, L.-T.; Bentler, P.M. Fit indices in covariance structure modeling: Sensitivity to under parameterized model misspecification. *Psychol. Methods* **1998**, *3*, 424–453. [CrossRef]
27. Hu, L.-T.; Bentler, P.M. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct. Equ. Model. Multidiscip. J.* **1999**, *6*, 1–55. [CrossRef]
28. Raftery, A.E. Bayesian model selection in social research. *Sociol. Methodol.* **1995**, *25*, 111–163. [CrossRef]
29. Bentler, P.M.; Freeman, E.H. Tests for stability in linear structural equation systems. *Psychometrika* **1983**, *48*, 143–144. [CrossRef]
30. Raykov, T.; Penev, S. On structural equation model equivalence. *Multivar. Behav. Res.* **1999**, *34*, 199–244. [CrossRef]
31. Alvaro, E.M.; Crano, W.D. Minority influence: Evidence for lenience in source evaluation and counterargumentation. *J. Pers. Soc. Psychol.* **1997**, *72*, 949–964. [CrossRef]
32. Dillard, J.P.; Cruz, S.M.; Shen, L. Spillover effects of anti-sugar-sweetened beverage messages: From consumption decisions to policy preferences. *Soc. Sci. Med.* **2023**, *320*, 115693. [CrossRef]
33. Brannon, S.M.; DeJong, A.; Gawronski, B. Determinants of lateral attitude change: The roles of object relatedness, attitude certainty, and moral conviction. *Soc. Cogn.* **2019**, *37*, 624–658. [CrossRef]
34. Hunter, J.E.; Levine, R.L.; Sayers, S.E. Attitude change in hierarchical belief systems and its relationship to persuasibility, dogmatism, and rigidity. *Hum. Commun. Res.* **1976**, *3*, 3–28. [CrossRef]
35. Fink, E.L.; Smith, R.A.; Cai, D.A.; Jung, H. How Americans make sense of two novel pandemics. *Health Commun.* **2021**, *37*, 548–560. [CrossRef] [PubMed]
36. Zhou, Y.; Li, R.; Shen, L. Psychological profiles of COVID vaccine-hesitant individuals and implications for vaccine message design strategies. *Vaccine* **2023**, *13*, 100279. [CrossRef]

37. Shen, L.; Lee, D. Predicting COVID-19 and influenza vaccination confidence and uptake in the United States. *Vaccines* **2023**, *11*, 1597. [CrossRef]
38. Kim, M.-S.; Hunter, J.E. Relationships among attitudes, behavioral intentions, and behavior: A meta-analysis of past research II. *Commun. Res.* **1993**, *20*, 331–364. [CrossRef]