How Message Frames Promote People's Willingness to Get Vaccinated? The Mediation Role of Perceived Net Benefits

Jie Li[1], Zepeng Gong[1,2]*, Zhiwei Tang[1,2] and Jing Zhou[1]

[1]*School of Public Affairs and Administration, University of Electronic Science and Technology of China, Chengdu, China,*
[2]*Shenzhen Institute for Advanced Study, University of Electronic Science and Technology of China, Shenzhen, China*

Objectives: This study aims to evaluate the association among framed messages (egoism-, altruism-, and loss-framed information), perceived net benefits (PNB), and willingness to receive a COVID-19 vaccine.

Methods: A between-subject survey experiment was designed to assess the above association. A total of 1,316 individuals were included in this study. The participants were randomly assigned to one control group (receiving non-framed information) and three experimental groups (receiving egoism-, altruism-, and loss-framed information). The participants then reported their vaccination willingness and perceived effectiveness and side effects of vaccination. PNB was determined by subtracting the perceived side effects from perceived effectiveness.

Results: Compared with the control group, participants in the experimental groups exhibited stronger vaccination willingness. Higher PNB levels were associated with enhanced vaccination willingness. However, only loss-framed messages indirectly affected vaccination willingness through PNB.

Conclusion: PNB can mediate the impact of message framing on vaccination willingness. However, the mediation effect of PNB was only found in the relationship between loss-framed messages and vaccination willingness.

Keywords: mediation, COVID-19, vaccination willingness, perceived net benefits, loss-framed, egoism-framed, altruism-framed

INTRODUCTION

Vaccination strategy is crucial in controlling pandemics resulting from infectious diseases, such as the coronavirus disease 2019 (COVID-19) [1,2]. However, since vaccination is generally a non-mandatory voluntary act [3], the success of this strategy depends on the acceptance of society to get vaccinated [4]. To this end, numerous studies have explored how to increase people's willingness to vaccinate, and found that vaccination decision-making shows a framing effect [5, 6]. In other words, framed messages, including egoism-, altruism-, and loss-framed information, can increase vaccination willingness [7–10]. This is supported by Prospect Theory, which suggests that different forms of information presentation can alter people's behavioral preferences [11, 12]. Nevertheless, it is still unclear how message framing enhances vaccination willingness, as most

studies only examine the direct association between framed information and vaccination willingness [13–16] or compare the relative persuasiveness of these message frames on vaccination [17–20]. Therefore, further studies should investigate the influencing mechanism of message framing on vaccination willingness.

Perceived net benefits (PNB) refer to an individual's subjective assessment of the costs and benefits of taking a certain behavior [21, 22]. PNB can be calculated by subtracting costs from benefits [23, 24]. The hypothesis of economic man indicates that an individual decides to have a certain behavior based on the trade-off between costs and benefits [25]. For instance, individuals actively implement a certain behavior when they perceive that the cost of taking action is less than the benefits (positive PNB). Conversely, people do not take the recommended behavior when they perceive that the cost of taking action is more than the benefits (negative PNB). This is also similar to the view expressed in the Value Framework, which believes that individuals tend to maximize the positive value of (benefits) and minimize the negative impact (costs) a product or service when purchasing the product or service [26, 27]. Overall, individuals who perceive a behavior with a higher PNB level are more likely to take the behavior.

Similarly, people decide to be vaccinated (or not) depending on the perceived costs and benefits [28–30]. Cost mainly refers to the individual's perception of the possible side effects of vaccination (perceived side effects) [31, 32]. Benefit mainly refers to the individual's perception of the effectiveness of vaccination against diseases (perceived effectiveness) [33, 34]. Studies have shown that the main factors that stop or encourage people from getting vaccinated are the fear of adverse reactions and the expectation that the vaccine will work, respectively [1, 35–37]. Therefore, PNB (perceived effectiveness minus perceived side effects) determines if a person will undergo vaccination or not.

Moreover, message frames may have positive impacts on PNB. Specifically, egoism- and altruism-framed information emphasizes the benefits of a behavior. People exposed to these framed messages perceive more benefit from the behavior [11, 38] and thus have higher PNB than those who receive non-framed information. Loss-framed information emphasizes what people will lose if they do not act. This makes them feel like they will lose less if they act (38–40), showing more PNB. Overall, framed messages may potentially amplify the net benefits of adopting a behavior.

In summary, framed information can increase PNB, which in turn promotes vaccination willingness. This implies that PNB mediates between framed information and vaccination willingness. Thus, this study aimed to examine whether PNB mediates the impact of message frames on vaccination willingness using the COVID-19 vaccine as an example. According to the aforementioned comments, the following three assumptions were proposed: people who receive framed messages exhibit a stronger vaccination willingness than those who receive non-framed information (H1); individuals exposed to framed information show a higher level of PNB (H2); and people with a higher level of PNB are more likely to get vaccinated (H3).

METHODS

Participants and Procedure

This study employed two sample recruitment processes: 1) snowball sampling method was used to recruit participants based on authors' interpersonal networks, and participants were asked to fill out a questionnaire and forward it further to others; 2) using the convenience sampling method, we posted advertisements on an online commercial survey platform named Credamo (https://www.credamo.com) and then recruited respondents through the sample bank of the platform. The inclusion criteria for eligible participants included being over 18 years of age and not receiving a COVID-19 vaccine. The participants were informed that the survey was anonymous and that they could withdraw at any time. Respondents who completed the questionnaire were to receive monetary subsidies. Notably, two simple attention-checking questions were designed to ensure the responses given were authentic. Only the participants who answered the attention-checking questions correctly were included in the study. Finally, a total of 1,316 participants were used for data analysis.

Survey Experiment Design

A between-subject experiment with four vignettes (one control group (non-framed vignette) and three experimental groups (egoism-framed, altruism-framed, and loss-framed vignettes)) was designed. All vignettes had the same background introduction on COVID-19. However, the vignettes of the experimental groups contained additional framing information about vaccination: For instance, egoism-framed information; "if you receive a COVID-19 vaccine, you can produce strong antibodies, and you will not be infected with COVID-19"; altruism-framed information; "since some people (elderly and children) cannot get COVID-19 vaccine, you need to be vaccinated to promote the formation of herd immunity in your community and reduce the possibility of infecting the elderly and children"; loss-framed information showed the losses of not getting vaccines (if you are not vaccinated, you cannot produce antibodies against COVID-19, and you have high chances of being infected when you accidentally come into contact with the virus). Participants were randomly assigned into the four groups through the randomization function of the Credamo platform. The participants in each group read the vignette and reported their willingness to get a COVID-19 vaccine.

Measurements
Vaccination Willingness
Vaccination willingness was evaluated using the question: "if the COVID-19 vaccine becomes available, are you willing to be vaccinated?" The scores ranged from 1 (extremely unwilling) (score = 1) to 5 (extremely willing).

TABLE 1 | Characteristics of sample (Chengdu, China. 2022).

Variables	Frequency/Range	Percent/Mean (SD)
Gender[a]		
Male	643	48.86
Female	673	51.14
Age(year)[a]		
18–30	466	35.41
31–40	298	22.65
41–50	441	33.51
>50	111	8.43
Education[a]		
Primary or below	20	1.52
Middle	107	8.13
High	254	19.30
College	227	17.25
Bachelor	585	44.45
Master	98	7.45
Ph.D.	25	1.90
Job[a]		
Government or public institution employee	292	22.19
State-owned enterprise employee	169	12.84
Private enterprise employee	314	23.86
Student	277	21.05
Farmer	81	6.16
Else	183	13.90
Perceived income[a]		
Very poor	43	3.27
Lower middle	355	26.98
Medium	799	60.71
Upper middle	107	8.13
Very good	12	0.91
Have a child[a]		
Yes	883	67.10
No	433	32.90
Have an elder[a]		
Yes	1133	86.09
No	183	13.91
Health status[b]	1–5	3.77 (0.79)
Perceived probability[b]	1–4	2.18 (0.74)
Perceived severity[b]	1–4	3.26 (0.75)
Perceived net benefits[b]	1–5	1.28 (1.45)
Vaccination willingness[b]	1–5	4.31 (0.89)

[a]*Note. Frequency and percentage were reported.*
[b]*Range and mean values (standard deviations) were reported.*

Perceived Net Benefits

PNB was calculated by subtracting perceived side effects from perceived effectiveness Perceived effectiveness was assessed using the question: "Do you think the COVID-19 vaccine is effective?" The scores ranged from 1 (not at all) to 5 (very effective). Perceived side effects were assessed using the question; "are you worried about the side effects of COVID-19 vaccine"? The scores ranged from 1 (not worried at all) to 5 (extremely worried).

Control Variables

The control variables in this study included gender (male/female), age (18–30, 31–40, 41–50, and above 50 years), education (primary school or below, middle school, high school, junior college, bachelor degree, master degree, and Ph.D.), job (government or public institution employee, state-owned enterprise employee, private-owned enterprise employee, farmer, student, and others), perceived income (very poor, lower-middle, medium, upper-middle, and very good), presence of a child/children (yes/no), presence of an elderly member in the family (yes/no), health status, and perceived probability and severity of COVID-19, (based on previous studies [4, 10, 39, 40]. An individual's health status was assessed using the question "how is your health?" The scores ranged from 1 (very bad) to 5 (very good). Perceived probability was assessed using the question "how likely do you think you will be infected with COVID-19?" The scores ranged from 1 (very unlikely) to 4 (very likely). The perceived severity of getting COVID-19 was evaluated using the question, "how serious do you think it is to get COVID-19?" The scores ranged from 1 (not serious at all) (score = 1) to 4 (very serious).

Data Analysis

The characteristics of frequency (mean ± standard deviation) and percentage (range) of each variable were described. The differences in socio-demographics (gender, age, education, job,

TABLE 2 | Associations between message frames, perceived net benefits, and vaccination willingness (Chengdu, China. 2022).

Variables	Unadjusted		Adjusted	
	Perceived net benefits	Willingness	Perceived net benefits	Willingness
Message frame (ref: non-framed)				
Egoism-framed	0.06 (0.11)	0.31*** (0.06)	0.10 (0.11)	0.29*** (0.06)
Altruism-framed	0.18 (0.11)	0.29*** (0.06)	0.20 (0.11)	0.28*** (0.06)
Loss-framed	0.31** (0.11)	0.43*** (0.06)	0.33** (0.11)	0.41*** (0.06)
Perceived net benefits		0.23*** (0.02)		0.23*** (0.02)

*Note. All control variables were adjusted in the adjusted models, but not reported due to page limitation; Standard errors in parentheses; **p < 0.01, ***p < 0.001.*

perceived income) among the four groups were examined using Chi-square tests or ANOVA analyses. The assumptions were tested using a seemingly unrelated regression (SUR) method: The models (unadjusted and adjusted models) were assessed as described by Zellner [41]: 1) the effect of message frames (egoism-, altruism-, and loss-framed information) on PNB, and 2) the effect of message frames and PNB on vaccination willingness. The potential mediation effects were assessed using a bias-corrected bootstrap method with 5,000 replications [42]. Moreover, the impact of message frames on perceived effectiveness and side effects was evaluated using *ad hoc* analyses to clarify how message frames influence PNB. $p < .05$ was considered statistically significant. SPSS version 21.0 was used for all analyses.

RESULTS

Descriptive Results

Characteristics of the participants are shown in **Table 1**. The control, egoism-framed, altruism-framed, and loss-framed groups had 333, 321, 335, and 327 participants, respectively. A total of 673 participants were females (51.14%), and 643 were males (48.86%). About 35.41%, 22.65%, 33.51%, and 8.43% of the participants were aged 18–30 years, 31–40 years, 41–50 years, and over 50 years, respectively. Most respondents (86.09%) had an elderly member in their family, and about 67.10% had a child/children. About 71.04% of the respondents had an education level of junior college or above. About 69.75% perceived their income as medium or above. Furthermore, the mean ± standard deviation of vaccination willingness, PNB, health status, perceived probability, and perceived severity was 4.31 ± .89, 1.28 ± 1.45, 3.77 ± .79, 2.18 ± .74, and 3.26 ± .75, respectively. Moreover, gender, age, education, job, and perceived income were not significantly different among the four groups.

SUR Results

The hypothesis test results are summarized in **Table 2**. The unadjusted and adjusted models showed that only loss-framed messages significantly and positively impacted PNB compared with non-framed information (unadjusted: $\beta = .31$, $p < .01$; adjusted: $\beta = .33$, $p < .01$). However, the three framed messages significantly and positively influenced vaccination willingness. For instance, in the adjusted model, the participants exposed to the egoism-framed ($\beta = .29$, $p < .001$),

altruism-framed ($\beta = .28$, $p < .001$), and the loss-framed messages ($\beta = .41$, $p < .001$) reported a stronger willingness to be vaccinated than those who received non-framed information. Moreover, higher PNB level was significantly associated with higher vaccination willingness ($\beta = .23$, $p < .001$). These results indicate that PNB only mediates the association between loss-framed information and vaccination willingness (**Figure 1**). Bootstrap analysis results also confirmed the indirect effect of loss-framed information on vaccination willingness through PNB ($\beta = .07$, 95% biased CI: .03, .12).

Ad-Hoc Analysis Results

The associations between message frames with perceived effectiveness and side effects are shown in **Table 3**. Compared with subjects exposed to non-framed information, participants exposed to loss-framed information felt vaccination was more effective ($\beta = .12$, $p < .05$) and perceived that the side effects of vaccination were weaker ($\beta = -.21$, $p < .01$). In contrast, the egoism- and altruism-framed information did not significantly affect the perceived effectiveness and side effects.

DISCUSSION

Using a representative sample of the Chinese population, this study sought to determine how framed messages (loss-, egoism-, and altruism-framed information) affect vaccination willingness *via* PNB. This is the first study to examine the influencing mechanism of message frames on vaccination to the best of our knowledge. The findings of this study provide useful knowledge on how loss-framed information increases vaccination willingness and why loss-framed information has advantages in promoting vaccination compared with the other two message frames (egoism and altruism). Therefore, this study may provide new theoretical insights into the impact of message frames on health behavior.

First, consistent with previous studies [3, 7–10], individuals who received framed messages (egoism-, altruism-, and loss-framed messages) were more likely to get vaccinated than those who received non-framed messages. People adopt recommended behavior when provided with information highlighting the positive outcomes of behavior (egoism-framed and altruism-framed) or negative outcomes (loss-framed) [38, 43, 44]. This is consistent with the views expressed in the Prospect theory [11, 38], that is, information emphasizing the potential benefits of
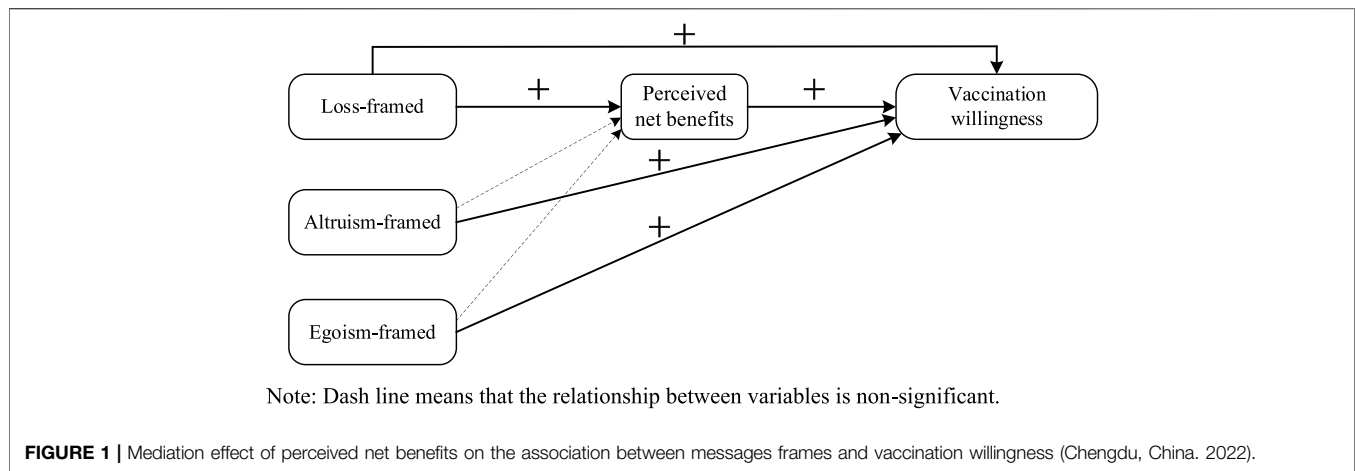
Note: Dash line means that the relationship between variables is non-significant.

FIGURE 1 | Mediation effect of perceived net benefits on the association between messages frames and vaccination willingness (Chengdu, China. 2022).

TABLE 3 | Effects of message frames on perceived effectiveness and side effects (Chengdu, China. 2022).

Variables	Perceived effectiveness	Perceived side effects
Message frame (ref: non-framed)		
Egoism-framed	0.08 (0.06)	−0.03 (0.07)
Altruism-framed	0.08 (0.06)	−0.13 (0.07)
Loss-framed	0.12* (0.06)	−0.21** (0.07)

*Note: All control variables were adjusted in the models, but not reported due to page limitation; Standard errors in parentheses; *p < 0.05, **p < 0.01.*

performing a behavior or the potential costs of not doing so can influencing people's behavior decision-making. Moreover, the coefficient of loss-framed messages with vaccination was higher than that of egoism- and altruism-framed messages, indicating that loss-framed messages have a stronger effect on persuading people to be vaccinated than the other two framed messages. This supports previous findings that emphasizing the possible losses or disadvantages of not getting a vaccine is more persuasive than emphasizing the benefits or advantages of vaccination among individuals who perceive vaccination as risky [9, 10, 19]. Overall, these results show that framed messages, especially loss-framed messages, are effective strategies for improving vaccination willingness.

Second, people with higher PNB exhibited stronger vaccination willingness. This is consistent with the previous findings that individuals usually measure the net benefits of taking a behavior before deciding whether to adopt the behavior [21, 24]. Therefore, PNB is an appropriate criterion for individual behavioral decision-making [45], and thus vaccination willingness can be enhanced by increasing an individual's PNB. Moreover, PNB in this study was measured by subtracting perceived side effects from the perceived effectiveness of vaccination. Thus, PNB can be increased by improving people's perception of the effectiveness of vaccination and reducing concerns about the side effects of vaccines.

Third, PNB mediated the association between framed messages and vaccination willingness. Notably, the mediating role of PNB was only established in the impact path between loss-framed messages and vaccination willingness. Therefore, only loss-framed messages increased the PNB levels, directly improving vaccination willingness. Furthermore, loss-framed messaging affects PNB by decreasing the perceived side effects of vaccination and increasing the perceived effectiveness of immunization. This indicates that highlighting the losses of not adopting a behavior lowers the individual's perception of costs of adopting the behavior and raises the perception of benefits of the behavior. For the former, it is simple because the meaning expressed by the loss-framed information is the potential loss from not acting, and thus it is easy for people to perceive that taking action will reduce the loss [11, 38, 46]. Regarding the latter, one possible explanation is that people may develop a sense of loss of not acting in loss-framed information. This would contrast the perceptions of behavioral effects that people originally held, thereby further amplifying the perceived behavioral benefits. Non-etheless, this interpretation remains speculative until conclusive empirical evidence is available.

Surprisingly, inconsistent with prior research which showed that framed information stating benefits can affect PNB [47], no significant association was found between gain-framed (egoism- and altruism-framed) messages and PNB in this study. This suggests that PNB cannot explain the effects of these two types of framed messages on vaccination. Thus, we acknowledge that the present study did not explore the influencing mechanism of these two message frames on vaccination. Furthermore, egoism- and altruism-framed messages have no significant positive effect on perceived effectiveness. This is inconsistent with previous findings [11, 38, 48] that egoism- and altruism-framed information emphasizing the gains of a behavior could increase the perception of benefits of taking the behavior. We speculate that the discrepancy could be because the study was conducted at the beginning of the COVID-19 vaccine launch. As a new vaccine, people were mainly concerned about the side effects of the vaccine at the time [31, 32], and the actual effects of the vaccine on health promotion had not yet been seen. Therefore, these framed messages alone are not enough to improve people's perception of the effect of the vaccine.

This study can provide practical implications for the development of vaccination strategy. According to the positive

association between PNB and vaccination willingness, we believe that the practice departments need to adopt strategies to improve people's PNB. In this regard, it is meaningful to either enhance the perceived benefits of vaccination or reduce the perception of the side effects of vaccines. In addition, we recommend using message frames to construct vaccine information, as egoism-, altruism-, and loss-framed information can directly promote people's willingness to be vaccinated. Of course, we particularly recommend the use of a loss-framed information construction approach to highlight the potential loss of not vaccinating, because it can also indirectly promote vaccination through PNB.

The present study has some limitations. First, vaccination willingness was used to represent the actual vaccination behavior. However, willingness cannot guarantee actual behavior [49]. Second, PNB measurement is not particularly accurate since perceived effectiveness and side effects were used to represent benefits and costs, respectively. However, the benefits and costs of vaccination can come from many sources. Moreover, the influencing mechanism of egoism/altruism-framed messages on vaccination willingness should be further explored in the future.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the University of Electronic Science and Technology of China. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JL and ZG conceptualized and designed the study, analyzed and interpreted the data, and wrote the manuscript. ZT and JZ collected the data and validated the manuscript. All authors saw and approved the final version.

FUNDING

CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

REFERENCES

1. Ahmed NJ, Alkhawaja FZ, Alrawili AS. Barriers Influencing COVID-19 Vaccination Uptake Among the Public in Saudi Arabia. *J Pharm Res Int* (2021) 27–32. doi:10.9734/jpri/2021/v33i731198

2. Sasaki S, Saito T, Ohtake F. Nudges for COVID-19 Voluntary Vaccination: How to Explain Peer Information? *Soc Sci Med* (2022) 292:114561. doi:10.1016/j.socscimed.2021.114561

3. Li J, Tang Z, Gong Z. Does the Message Frame Promote People's Willingness to Vaccinate when They Worry about Side Effects from the COVID-19 Vaccine? Evidence from an Online Survey Experiment in China. *Health Commun* (2022) 0:1–9. doi:10.1080/10410236.2022.2028469

4. Williams L, Gallant AJ, Rasmussen S, Brown Nicholls LA, Cogan N, Deakin K, et al. Towards Intervention Development to Increase the Uptake of COVID-19 Vaccination Among Those at High Risk: Outlining Evidence-based and Theoretically Informed Future Intervention Content. *Br J Health Psychol* (2020) 25:1039–54. doi:10.1111/bjhp.12468

5. Altay S, Mercier H. Framing Messages for Vaccination Supporters. *J Exp Psychol Appl* (2020) 26:567–78. doi:10.1037/xap0000271

6. Sudharsanan N, Favaretti C, Hachaturyan V, Barnighausen T, Vandormael A. Effects of Side-Effect Risk Framing Strategies on COVID-19 Vaccine Intentions: a Randomized Controlled Trial. *eLife* (2022) 11:e78765. doi:10.7554/eLife.78765

7. Nan X, Madden K, Richards A, Holt C, Wang MQ, Tracy K. Message Framing, Perceived Susceptibility, and Intentions to Vaccinate Children against HPV Among African American Parents. *Health Commun* (2016) 31:798–805. doi:10.1080/10410236.2015.1005280

8. Arnesen S, Bærøe K, Cappelen C, Carlsen B. Could Information about Herd Immunity Help Us Achieve Herd Immunity? Evidence from a Population Representative Survey experiment. *Scand J Public Health* (2018) 46:854–8. doi:10.1177/1403494818770298

9. Liu S, Yang JZ, Chu H. Now or Future? Analyzing the Effects of Message Frame and Format in Motivating Chinese Females to Get HPV Vaccines for Their Children. *Patient Educ Couns* (2019) 102:61–7. doi:10.1016/j.pec.2018.09.005

10. Gong Z, Tang Z, Li J. What Strategy Is Better for Promoting COVID-19 Vaccination? A Comparison between Gain-Framed, Loss-Framed, and Altruistic Messages. *Ann Behav Med* (2022) 56:325–31. doi:10.1093/abm/kaab070

11. Tversky A, Kahneman D. The Framing of Decisions and the Psychology of Choice. *Science* (1981) 211:453–8. doi:10.1126/science.7455683

12. Tversky A, Kahneman D. Advances in prospect Theory: Cumulative Representation of Uncertainty. *J Risk Uncertain* (1992) 5:297–323. doi:10.1007/BF00122574

13. Detweiler JB, Bedell BT, Salovey P, Pronin E, Rothman AJ. Message Framing and Sunscreen Use: Gain-Framed Messages Motivate beach-goers. *Health Psychol Off J Div Health Psychol Am Psychol Assoc* (1999) 18:189–96. doi:10.1037//0278-6133.18.2.189

14. Abhyankar P, O'connor DB, Lawton R. The Role of Message Framing in Promoting MMR Vaccination: Evidence of a Loss-Frame Advantage. *Psychol Health Med* (2008) 13:1–16. doi:10.1080/13548500701235732

15. O'Keefe DJ, Jensen JD. The Relative Persuasiveness of Gain-Framed and Loss-Framed Messages for Encouraging Disease Prevention Behaviors: a Meta-Analytic Review. *J Health Commun* (2007) 12:623–44. doi:10.1080/10810730701615198

16. O'Keefe DJ, Nan X. The Relative Persuasiveness of Gain- and Loss-Framed Messages for Promoting Vaccination: A Meta-Analytic Review. *Health Commun* (2012) 27:776–83. doi:10.1080/10410236.2011.640974

17. Rothman AJ, Salovey P. Shaping Perceptions to Motivate Healthy Behavior: the Role of Message Framing. *Psychol Bull* (1997) 121:3–19. doi:10.1037/0033-2909.121.1.3

18. Rothman AJ, Bartels RD, Wlaschin J, Salovey P. The Strategic Use of Gain- and Loss-Framed Messages to Promote Healthy Behavior: How Theory Can Inform Practice. *J Commun* (2006) 56:S202–20. doi:10.1111/j.1460-2466.2006.00290.x

19. Nan X. Relative Persuasiveness of Gain- versus Loss-Framed Human Papillomavirus Vaccination Messages for the Present- and Future-Minded. *Hum Commun Res* (2012) 38:72–94. doi:10.1111/j.1468-2958.2011.01419.x

20. Nan X, Madden K. The Role of Cultural Worldviews and Message Framing in Shaping Public Opinions toward the Human Papillomavirus Vaccination Mandate: Cultural Worldviews and Message Framing. *Hum Commun Res* (2014) 40:30–53. doi:10.1111/hcre.12016

21. Willems JS. Cost Effectiveness and Cost Benefit of Vaccination against Pneumococcal Pneumonia. Implications for Clinical Practice. *Infect Control* (1982) 3:299–302. doi:10.1017/S019594170005637X

22. Johannesson M, Weinstein MC. On the Decision Rules of Cost-Effectiveness Analysis. *J Health Econ* (1993) 12:459–67. doi:10.1016/0167-6296(93)90005-Y

23. Phillips KA, Holtgrave DR. Using Cost-Effectiveness/Cost- Benefit Analysis to Allocate Health Resources: A Level Playing Field for Prevention? *Am J Prev Med* (1997) 13:18–25. doi:10.1016/S0749-3797(18)30219-8

24. Fenwick E, Claxton K, Sculpher M. Representing Uncertainty: the Role of Cost-Effectiveness Acceptability Curves. *Health Econ* (2001) 10:779–87. doi:10.1002/hec.635

25. Godkin EL. The Economic Man. *North Am Rev* (1891) 153:491–503.

26. Peter JP, Tarpey LX. A Comparative Analysis of Three Consumer Decision Strategies. *J Consum Res* (1975) 2:29–37. doi:10.1086/208613

27. Ozturk AB, Bilgihan A, Salehi-Esfahani S, Hua N. Understanding the mobile Payment Technology Acceptance Based on Valence Theory: A Case of Restaurant Transactions. *Int J Contemp Hosp Manag* (2017) 29:2027–49. doi:10.1108/IJCHM-04-2016-0192

28. Weinstein ND. Testing Four Competing Theories of Health-Protective Behavior. *Health Psychol* (1993) 12:324–33. doi:10.1037//0278-6133.12.4.324

29. Kumpulainen V, Mäkelä M. Influenza Vaccination Among Healthy Employees: A Cost-Benefit Analysis. *Scand J Infect Dis* (1997) 29:181–5. doi:10.3109/00365549709035881

30. Newall AT, Chen C, Wood JG, Stockwell MS. Within-season Influenza Vaccine Waning Suggests Potential Net Benefits to Delayed Vaccination in Older Adults in the United States. *Vaccine* (2018) 36:5910–5. doi:10.1016/j.vaccine.2018.08.007

31. Alabdulla M, Reagu SM, Al-Khal A, Elzain M, Jones RM. COVID-19 Vaccine Hesitancy and Attitudes in Qatar: A National Cross-sectional Survey of a Migrant-majority Population. *Influenza Other Respir Viruses Irv* (2021) 15:361–70. doi:10.1111/irv.12847

32. Unroe KT, Evans R, Weaver L, Rusyniak D, Blackburn J. Willingness of Long-Term Care Staff to Receive a COVID -19 Vaccine: A Single State Survey. *J Am Geriatr Soc* (2021) 69:593–9. doi:10.1111/jgs.17022

33. Sherman SM, Smith LE, Sim J, Amlot R, Cutts M, Dasch H, et al. COVID-19 Vaccination Intention in the UK: Results from the COVID-19 Vaccination Acceptability Study (CoVAccS), a Nationally Representative Cross-Sectional Survey. *Hum Vaccin Immunother* (2021) 17:1612–21. doi:10.1080/21645515.2020.1846397

34. Burke PF, Masters D, Massey G. Enablers and Barriers to COVID-19 Vaccine Uptake: An International Study of Perceptions and Intentions. *Vaccine* (2021) 39:5116–28. doi:10.1016/j.vaccine.2021.07.056

35. Wang J, Jing R, Lai X, Zhang H, Lyu Y, Knoll MD, et al. Acceptance of COVID-19 Vaccination during the COVID-19 Pandemic in China. *Vaccines* (2020) 8:482. doi:10.3390/vaccines8030482

36. Lin Y, Hu Z, Zhao Q, Alias H, Danaee M, Wong LP. Understanding COVID-19 Vaccine Demand and Hesitancy: A Nationwide Online Survey in China. *Plos Negl Trop Dis* (2020) 14:e0008961. doi:10.1371/journal.pntd.0008961

37. Kaur RJ, Dutta S, Bhardwaj P, Charan J, Dhingra S, Mitra P, et al. Adverse Events Reported from COVID-19 Vaccine Trials: A Systematic Review. *Indian J Clin Biochem* (2021) 2322:427–39. doi:10.1007/s12291-021-00968-z

38. Kahneman D, Tversky A. Prospect Theory: An Analysis of Decision under Risk. *Econometrica* (1979) 47:263–91. doi:10.2307/1914185

39. Carlsen B, Glenton C. The Swine Flu Vaccine, Public Attitudes, and Researcher Interpretations: A Systematic Review of Qualitative Research. *BMC Health Serv Res* (2016) 16:203–15. doi:10.1186/s12913-016-1466-7

40. Gong Z, Veuthey J, Han Z. What Makes People Intend to Take Protective Measures against Influenza? Perceived Risk, Efficacy, or Trust in Authorities. *Am J Infect Control* (2020) 48:1298–304. doi:10.1016/j.ajic.2020.07.029

41. Zellner A. An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias. *J Am Stat Assoc* (1962) 57:348–68. doi:10.1080/01621459.1962.10480664

42. Hayes AF, Scharkow M. The Relative Trustworthiness of Inferential Tests of the Indirect Effect in Statistical Mediation Analysis: Does Method Really Matter? *Psychol Sci* (2013) 24:1918–27. doi:10.1177/0956797613480187

43. Lauver D, Rubin M. Message Framing, Dispositional Optimism, and Follow-Up for Abnormal Papanicolaou Tests. *Res Nurs Health* (1990) 13:199–207. doi:10.1002/nur.4770130309

44. Kim HM, Kim E, Murphy S. Testing the Effectiveness of Message Framing and Episodic Future Thinking in Promoting HPV Vaccination via Anticipated Regret. *Health Commun* (2020) 37:525–34. doi:10.1080/10410236.2020.1855744

45. Parlevliet W, de Borgie C, Frijstein G, Guchelaar H-J. Cost-Benefit Analysis of Vaccination against Influenza of Employees from an Academic Medical Centre. *Dis Manag Health Outcomes* (2002) 10:579–87. doi:10.2165/00115677-200210090-00006

46. Tversky A, Kahneman D. Loss Aversion in Riskless Choice: A Reference-dependent Model. *Q J Econ* (1991) 106:1039–61. doi:10.2307/2937956

47. Sheridan SL, Sutkowi-Hemstreet A, Barclay C, Brewer NT, Dolor RJ, Gizlice Z, et al. A Comparative Effectiveness Trial of Alternate Formats for Presenting Benefits and Harms Information for Low-Value Screening Services: A Randomized Clinical Trial. *JAMA Intern Med* (2016) 176:31–41. doi:10.1001/jamainternmed.2015.7339

48. Vietri JT, Li M, Galvani AP, Chapman GB. Vaccinating to Help Ourselves and Others. *Med Decis Making* (2012) 32:447–58. doi:10.1177/0272989X11427762

49. Webb TL, Sheeran P. Does Changing Behavioral Intentions Engender Behavior Change? A Meta-Analysis of the Experimental Evidence. *Psychol Bull* (2006) 132:249–68. doi:10.1037/0033-2909.132.2.249