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Effective or ineffective: Attribute framing and the human papillomavirus (HPV) vaccine

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ABSTRACT

Objective: To experimentally test whether presenting logically equivalent, but differently valenced effectiveness information (i.e. attribute framing) affects perceived effectiveness of the human papillomavirus (HPV) vaccine, vaccine-related intentions and policy opinions.
Methods: A survey-based experiment ($N = 334$) was fielded in August and September 2007 as part of a larger ongoing web-enabled monthly survey, the Annenberg National Health Communication Survey. Participants were randomly assigned to read a short passage about the HPV vaccine that framed vaccine effectiveness information in one of five ways. Afterward, they rated the vaccine and related opinion questions. Main statistical methods included ANOVA and *t*-tests.
Results: On average, respondents exposed to positive framing (70% effective) rated the HPV vaccine as more effective and were more supportive of vaccine mandate policy than those exposed to the negative frame (30% ineffective) or the control frame. Mixed valence frames showed some evidence for order effects; phrasing that ended by emphasizing vaccine ineffectiveness showed similar vaccine ratings to the negative frame.
Conclusion: The experiment finds that logically equivalent information about vaccine effectiveness not only influences perceived effectiveness, but can in some cases influence support for policies mandating vaccine use.
Practice implications: These framing effects should be considered when designing messages.

1. Introduction

The media, health professionals and social contacts often play a role in raising awareness about health issues. This is particularly true when the health issue is unfamiliar. In June 2006, Merck launched a first of a kind human papillomavirus (HPV) vaccine into the U.S. market for girls and women aged 9–26 [1]. Clinical trial results suggested that the Merck vaccine (Gardasil) protected against two HPV strains (18 and 16) that account for roughly 70% of cervical cancers and two other HPV strains (6 and 11) linked to 90% of genital warts.

Despite the fact that HPV is thought to be the most common sexually transmitted infection in the U.S., prior to the media coverage surrounding the new vaccine, few people in the U.S. or in other countries were familiar with the HPV virus, its status as a sexually transmitted disease or its role in causing cervical cancer [2,3]. Even so, physicians, parents and adolescents were generally accepting of the vaccine and interested in obtaining more information about HPV [4,5].

In light of the HPV vaccine's potential to prevent serious health problems like cervical cancer and genital warts, a number of measures to facilitate vaccine adoption were initially proposed by the U.S. public health and medical community, including securing endorsements from key professional organizations, conducting educational campaigns, covering the cost of the vaccination, and perhaps most controversial, legislating mandatory vaccination of eligible school girls.

The HPV vaccine's novelty combined with its planned indication for girls and the fact that it was for a sexually transmitted disease helped to generate controversy and spur media coverage even before the vaccine's release. The controversy has intensified since the vaccine's approval, particularly as states moved to put in place mandatory vaccination policies and opponents raised concerns about political improprieties, the impact on teen promiscuity and the long-term safety and effectiveness of the vaccine [6]. Battles over vaccine mandates and questions about vaccine safety and effectiveness are recurring themes in the history of vaccination policy in the U.S. [7].

1.1. Perceived effectiveness: a key vaccine attribute

Studies that have looked at vaccine acceptance indicate that perceived vaccine effectiveness is a fundamental consideration.

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This paper focuses specifically on whether the way in which equivalent effectiveness information is presented can result in different perceptions of HPV vaccine effectiveness and what implications that has for opinion about the vaccine and related outcomes, including beliefs about policy.

Early research into HPV vaccine acceptance showed adolescent women were sensitive to vaccine efficacy, along with physician endorsement and cost [8]. Perhaps unsurprisingly, people prefer more efficacious vaccines to those with lower efficacy rates [9]. A more recent review of 28 U.S. HPV vaccine acceptance studies confirms these earlier findings about effectiveness and cost [10].

To gain approval to market a vaccine, companies must conduct studies to show vaccine safety and efficacy. Consequently, a vaccine enters the U.S. market with some empirically determined efficacy or efficacy range based on one or more studies. However, even when there is one particular agreed upon efficacy figure, the same efficacy information can be framed in different ways.

Generally speaking, vaccine efficacy information can be verbal or quantitative and can be presented using fairly general or specific language. Information may focus on certain strains of a disease or it may highlight vaccine ability or inability to protect against the entire disease constellation. For instance, a vaccine could protect fully against several strains of the flu or some HIV clades or strains, but may not confer full protection against the flu or AIDS. Although commonly thought of as a single disease, many viral infections like HIV/AIDS and the flu can be caused by a number of different types of viral strains. Similarly, a number of high-risk strains of HPV can cause cervical cancer and genital warts. In this case, the Merck vaccine targets four specific strains (6, 11, 16 and 18) that account for a majority of, but not all, cervical cancer and genital wart cases.

Given the essential role that perceived effectiveness plays when it comes to medical treatments and preventative measures, it should not be surprising to find that news coverage of HPV vaccination often includes information that describes vaccine efficacy. HPV-related content analyses have been conducted with the goal of describing what kinds of information the media is conveying to the public about HPV [11].

A content analysis of media coverage of the HPV vaccine prior to its approval found that 20 (80%) of the articles reviewed did provide efficacy information about the vaccine [12]. However, this information varied. About half of the articles gave vague descriptors like "successful" and "effective" to describe the vaccine, while the other half included percentages. A subsequent content analysis that included the time period in which the vaccine was introduced onto the market found 95% of news included HPV vaccine efficacy information [13].

In sum, vaccine effectiveness plays a crucial role in vaccine acceptability, yet the same vaccine efficacy information can be conveyed to the public in different ways. Further, HPV vaccine effectiveness has been covered and communicated in the news in different ways.

1.2. Attribute framing in health communication

Framing studies suggest that the way in which logically equivalent information is presented can impact health preferences and behavior [14–17]. Much of the framing literature in the field traces its theoretical underpinnings to Kahneman and Tversky's Prospect Theory [18,19]. Kahneman and Tversky were able to show when information is presented in certain ways, people systematically opt for a statistically less advantageous payout structure or respond to one presentation of logically equivalent information over another. People make inferences based on the context in which choices are presented, such as the way in which information is framed. They also bring their own individual predispositions to bear on the information.

In their seminal article, Levin, et al. distinguish among three types of frames – risky choice frames, goal frames and attribute or valence frames [17]. In the realm of health communication, researchers have often applied Prospect Theory to craft messages based on attaining or failing to attain a goal related to health prevention and detection behaviors [14, but see 20]. That type of framing is goal or gain-loss framing. When a particular aspect or characteristic of something is described such that the positive aspect or its formally equivalent negative is highlighted, it is an example of what Levin et al. label "attribute framing" [17]. Also described in the literature as "outcome salience" or "valence framing", attribute framing tends to result in people being more amenable toward the object or treatment when it is framed positively.

In the health domain, attribute frames can describe efficacy rates, side effects and other outcomes for surgical treatments, vaccines, contraceptives, diagnostics, or medications. If a particular frame is included as part of a communication, it may intentionally or unwittingly affect perceived treatment efficacy and impact people's beliefs about personally using the health product or what kinds of policies should be associated with it. It may also impact beliefs about what policies should be put in place regarding the health product or likelihood of a person endorsing use of the technology. For instance, when students read that a condom had a "90% success rate" against HIV transmission, 86% said the government should be allowed to advertise the condom as "an effective method for reducing the risk of AIDS" and 85% said they would use it or encourage their partner to use it [21]. However, when the condom was described as having a 10% failure rate, the support for government advertising was 61% and only 63% of people said they would use or recommend it.

An efficacy message can also be framed based on either success or failure to protect against a disease. For example, a vaccine might be portrayed as "effective against strains that account for 70% of cases of a disease" or "ineffective against strains that account for 30% of cases." The emphasis is either on vaccination efficacy, or its flip side, vaccine limitations. In fact, it has been widely reported that the HPV vaccine is 70% effective [22]. Occasionally, media reports have just presented percentages related to the vaccine's inability to protect against strains that cause 30% of cervical cancers [23]. Mixed frames that include both figures are not uncommon in news articles [24,25]. Government sources, such as the Centers for Disease Control & Prevention, have also utilized mixed frames, including negative frames [1]. Research suggests it is possible that this kind of coverage may influence perceptions of the HPV vaccine.

Positively framed information regarding safety (90% chance of no side effects versus 10% chance of side effects) for a hypothetical infant vaccine was associated with more positive attitudes toward vaccination and combined intention to either seek more information or vaccinate [26]. Others have found similar framing effects for vaccinations [27]. When O'Connor, Pennie and Dales framed vaccine information positively (based on percentages and ratios of people remaining free of the flu and flu shot side effects), it resulted in more positive perceptions of the vaccine and its side effects. Furthermore, the expectations were more accurate compared to objective criteria. However, these perceptions did not translate into a difference in vaccine adoption. On the other hand, those who saw the positively framed information and did opt for vaccination reported fewer post-vaccination side effects and less work absenteeism. Thus, research finds that attribute framing can impact vaccine attitudes and in some circumstances may impact prevention-related policy support and vaccination-related intentions and behavior.

In sum, vaccine effectiveness plays a crucial role in vaccine acceptability, yet the same vaccine efficacy information can be

conveyed to the public in different ways. Further, HPV vaccine effectiveness has been covered and communicated in the news in different ways. The theory surrounding attribute framing strongly suggests that the way in which vaccine effectiveness is framed can affect perceived HPV vaccine effectiveness specifically, and vaccine support more generally. For these reasons, it is worth asking whether the manner in which essentially equivalent effectiveness information is framed affects perceptions of vaccine effectiveness, and more broadly, support for vaccination and vaccine-related policies.

1.3. Attribute framing and HPV vaccine effectiveness: an experimental test

Based on literature regarding attribute frames, it was expected that when participants were asked to rate the vaccine, the group that saw the positive attribute frame for vaccine effectiveness would view the vaccine more favorably than the group that saw the negative attribute frame. Therefore, it was hypothesized that attribute framing would result in differences in vaccine ratings across conditions. Specifically, the positive attribute frame would result in higher mean rating of HPV vaccine effectiveness than the negative attribute frame.

A control condition allows for the examination of whether the positive attribute and negative attribute conditions not only resulted in differences in perceived effectiveness, but also whether they differed from a baseline control [28]. Few studies of attribute frames in the health arena have included a control condition [15]. The choice of a no effectiveness information control makes sense not only from a theoretical perspective, but also is justified from a more applied perspective. Prior content analyses had found that while a large majority included effectiveness information for the HPV vaccine, not all articles did [12,13]. For these reasons, the experimental design included a control condition that presented the same background information shown in the other conditions, but excluded the effectiveness frame. It was expected that the positive attribute frame would result in a higher perceived effectiveness than the control condition and that the negative attribute frame would result in lower perceived effectiveness than the control condition.

Additionally, two mixed conditions were included because media coverage and official sources contained both the positive and the negative attribute frames in the same communication or news story. Therefore, it was considered important from an applied standpoint to explore the impact of having mixed messages. The mixed conditions were also included as a control for the positive and negative attribute frames in order to cover all valid logical combinations regarding the attribution frames in the experiment. The experiment was designed to counterbalance order in the mixed frames. If attribute frames trigger similarly valenced associations, mixed frames might dampen or altogether attenuate framing effects compared to purely positive or negative frames, depending on whether the affective associations triggered by the mixed frames are relatively balanced or if one affective dimension looms larger than the other.

The incorporation of mixed frames raises two questions. First, does the order of valenced frames matter? And second, do mixed frames produce results that differ from positive frames, negative frames or a control condition? Studies that include counterbalanced mixed frames have tended to conclude that there was no effect based on the order in which information was presented [29–31].

Results for combined mixed frames often have fallen between purely positive and negative frames. Yet, they also have produced conflicting findings as to whether the mixed frames were significantly different from negative frames, positive frames or neither. McNeil et al. found evidence for alignment with negative frames, and in one case, differences by gender [29]. By contrast, O'Connor et al. [30] and O'Connor [31] concluded that mixed frames were significantly different from negative, but not positive frames in the context of mortality versus survival framing. Thus, the question of directionality for mixed frames remains open.

Based on Levin et al.'s "valence consistent" shift hypothesis and Linville et al.'s finding with regard to condom recommendation, it was hypothesized that presenting purely positive frames for effectiveness would not only result in higher vaccine ratings related to that attribute, but also might influence more distal associations and affect beliefs, attitudes and intentions in such a way that the positive condition would result in more favorable beliefs and attitudes, and greater support for vaccination compared to the negative frame condition [17,21].

Consequently, it was expected that compared with those who saw the negative attribute frame, people who read the positive frame would perceive the vaccine to be more effective in preventing cervical cancer and also would be more favorable in their attitude toward vaccination as a strategy to prevent cervical cancer. Additionally, positive frames would lead respondents to be more favorable toward personal recommendation of the vaccine and to report a greater likelihood of voting for a hypothetical candidate who favored mandatory vaccination compared with the negative condition. In the Linville et al. study, framing effectiveness of condoms not only influenced personal intentions, but also opinion about whether the government should be allowed to advertise the condom as "an effective method for reducing the risk of AIDS" [21]. It was therefore hypothesized that compared to those who read the negative frame, people who saw the positive frame for HPV vaccine effectiveness would report more agreement with policies supportive of the vaccine.

2. Methods

2.1. Sample

A total of 334 respondents completed the experimental module in August (n = 171) and September (n = 163) 2007 as part of a larger ongoing web-enabled monthly survey, the Annenberg National Health Communication Survey (ANHCS). ANHCS panel participants are chosen using random-digit dialing; those who lack Internet service are provided access and hardware to enable their participation in the survey. Each month, ANHCS survey participants are selected from a previously established research panel designed to be representative of the U.S. population. The response rate for the survey was 31% and the completion rates for the survey for August and September were 72 and 69%, respectively. Respondents had an average age of 50 (SD = 16), 52% were female and 41% had an annual household income of $50,000 or more. Almost half had not attended college (48%), another quarter had some college (25%) and 27% had a college degree or higher. Just over three-quarters (77%) identified as non-Hispanic white, 9% were Hispanic and 9% non-Hispanic black. The remaining 5.1% were classified as other. More than a quarter of respondents (28%) had at least one daughter age 26 or younger. A small proportion of respondents (8%) reported that they or someone they knew had been diagnosed with HPV.

2.2. Design and procedure

The 1×5 factorial between subjects design experimentally tested whether different attribute frames for vaccine efficacy information affect perceived HPV vaccine effectiveness and other vaccine-related perceptions and opinions. Participants were randomly assigned to view one of five attribute frame conditions:

Table 1
Background text and attribute framing sentences by condition.

Please read the following paragraphs:
Human papillomavirus (HPV) infection is one of the most common sexually transmitted diseases. Many people will get HPV during their lifetime. It is prevalent in teens and young adults. In most cases, HPV has no symptoms and clears up on its own without treatment. However, some strains of the virus can cause cervical cancer and are considered high-risk.
In June 2006, the U.S. Food and Drug Administration approved an HPV vaccine for girls and young women aged 9–26. The vaccine was developed to protect against cervical cancer.
A national group of experts that advises the federal government on vaccine policy proposed that the government recommend that all eligible women and girls age 11 and older get the vaccination.
[Frame sentence]

Attribute frame condition	Frame sentence
Positive ($N = 85$)	The vaccine is effective against HPV strains that cause 70% of cervical cancers.
Mixed negative–positive ($N = 43$)	The vaccine is ineffective against HPV strains that cause 30% of cervical cancers. It is effective against strains that cause 70% of cervical cancers.
Control ($N = 81$)	None.
Mixed positive–negative ($N = 43$)	The vaccine is effective against HPV strains that cause 70% of cervical cancers. It is ineffective against strains that cause 30% of cervical cancers.
Negative ($N = 82$)	The vaccine is ineffective against HPV strains that cause 30% of cervical cancers.

attribute positive, attribute negative, a control condition or one of two mixed conditions that included both attribute positive and attribute negative information. All participants saw the same instructions and background information; only the final sentence(s) on vaccine effectiveness differed by condition (see Table 1).

Prior to viewing the stimulus paragraphs, participants completed questions assessing: demographic variables; involvement; knowledge and exposure; and general vaccine attitudes.

After reading the paragraphs, participants rated the vaccine and marked items related to personal intention and support for a number of policy-related beliefs. Lastly, respondents indicated to what extent they perceived the paragraphs they had just read to be accurate, believable, biased, confusing and interesting and completed a short multiple choice numeracy quiz. The analyses were conducted using SPSS version 15.

3. Results

3.1. Framing effects' influence on vaccine effectiveness ratings

The experimental framing resulted in HPV vaccine effectiveness ratings that are in line with what would be expected based on attribute framing theory. An omnibus test for main effects using analysis of variance (ANOVA) found differences in perceived effectiveness of the HPV vaccine by condition $F(4, 323) = 5.91$, $p \leq .001$, partial $\eta^2 = .068$ (see Fig. 1). There were no significant differences in randomization across conditions based on the demographic variables and pre-stimulus questions.

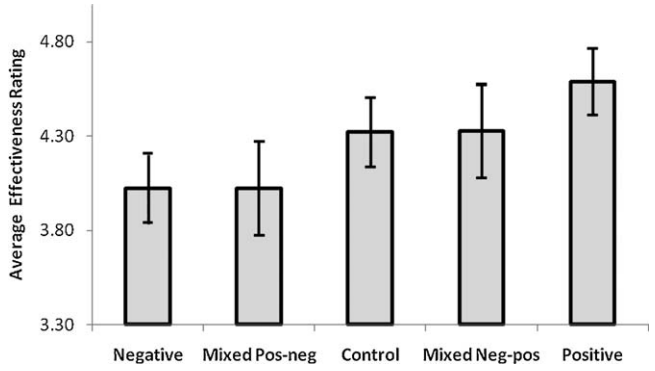

Fig. 1. HPV vaccine ratings by frame condition. *Note*: Vaccine rating measure ranges from 1 = completely ineffective to 6 = completely effective. Bars represent 95% confidence interval.

3.2. Pure valence frames

t-Tests confirmed our specific *a priori* hypotheses regarding perceived vaccine ratings. Exposure to the positive frame ($M_{pos} = 4.59$, $SD_{pos} = 0.71$) resulted in higher average perceived effectiveness compared to the negative frame ($M_{neg} = 4.03$, $SD_{neg} = 1.0$), $t(162) = 4.18$, $p \leq .001$. Those in the positive framing condition rated the HPV vaccine higher in terms of perceived effectiveness than those in the control condition ($M_{con} = 4.32$, $SD_{con} = 0.89$), $t(161) = 2.13$, $p \leq .05$. Average perceived effectiveness was lower in the negative framing group than the control, $t(155) = -1.95$, $p = .05$.

3.3. Mixed valence frames

A research question was posed about order when negative and positive attribute framing co-occurred. Order appeared to make a difference in vaccine effectiveness ratings. Those in the mixed negative–positive condition, the group that saw the negative frame first followed by the positive frame, rated the vaccine as more effective ($M_{mxneg} = 4.33$, $SD_{mxneg} = 0.64$) than the group that saw the positive frame first and the negative frame second, the mixed positive–negative condition ($M_{mxpos} = 4.02$, $SD_{mxpos} = 0.74$), $t(84) = 2.02$, $p \leq .05$. Using paired contrasts in the ANOVA rather than *t*-tests showed the same pattern of results for hypotheses, but showed marginal significance for the mixed frames ($p \leq .09$). Considering that the more direct comparison met the standard $p \leq .05$ threshold and the alternate testing method was also below $p \leq .10$, the mixed conditions were considered to be different and were not combined for subsequent analysis.

Consequently, the two mixed conditions were treated separately, because order appeared to influence perceived vaccine effectiveness differentially. The mixed positive–negative condition frame ($M_{mxpos} = 4.02$) was nearly identical to the pure negative frame's mean ($M = 4.03$) and was non-significant, $t(120) = .01$, *ns*, yet the mixed positive–negative frame was significantly different from the positive frame ($M_{pos} = 4.59$), $t(126) = 4.18$, $p \leq .001$. By contrast, the mixed negative–positive frame ($M_{mxneg} = 4.33$) marginally differed from the negative frame with regard to perceived vaccine efficacy $t(120) = 1.77$, $p = .08$ and was significantly different from the positive frame, $t(126) = 2.03$, $p \leq .05$. The mixed positive–negative frame marginally differed from the control, $t(119) = 1.87$, $p \leq .06$, while the mixed negative–positive frame was nearly identical to the control and therefore not significantly different, $t(119) = .03$, *ns*. Paired contrasts within the ANOVA give similar results in terms of significance and trend-level significance.

Table 2
Comparison of mandate versus non-mandate-related items: means (standard deviations) and statistical significance for *t*-test and ANOVA analyses.

Dependent variables	Negative	Mixed Pos–Neg	Control	Mixed Neg–Pos	Positive	Overall *F*
Non-mandate-related						
Recommend to close friend (1 = very unlikely, 5 = very likely)	3.52 (1.08)	3.44 (1.05)	3.53 (1.12)	3.60 (1.09)	3.62 (1.14)	.24
	n = 82	*n* = 43	*n* = 80	*n* = 43	*n* = 85	df = (4,328)
Recommend to family member (1 = very unlikely, 5 = very likely)	3.61 (1.01)	3.42 (1.12)	3.46 (1.11)	3.60 (1.14)	3.78 (1.07)	1.18
	n = 82	*n* = 43	*n* = 72	*n* = 43	*n* = 85	df = (4,326)
Parents should get daughters vaccinated (1 = strongly disagree, 5 = strongly agree)	3.68 (.97)	3.49 (1.03)	3.59 (1.04)	3.67 (1.07)	3.79 (1.07)	.73
	n = 81	*n* = 43	*n* = 80	*n* = 43	*n* = 85	df = (4,327)
Docs should recommend (1 = strongly disagree, 5 = strongly agree)	3.78 (1.13)	3.45 (1.13)	3.72 (1.16)	3.79 (1.07)	3.91 (.96)	1.26
	n = 81	*n* = 42	*n* = 81	*n* = 42	*n* = 85	df = (4,326)
Allow company to advertise as effective (1 = strongly disagree, 5 = strongly agree)	3.56 (1.08)	3.40 (1.07)	3.47 (1.14)	3.70 (.98)	3.52 (.98)	.50
	n = 81	*n* = 43	*n* = 81	*n* = 43	*n* = 85	df = (4,328)
Private insurance should cover (1 = strongly disagree, 5 = strongly agree)	4.16 (1.01)	3.83 (1.15)	4.09 (1.12)	4.21 (.99)	4.13 (1.03)	.87
	n = 81	*n* = 42	*n* = 81	*n* = 43	*n* = 85	df = (4,327)
Government should cover (1 = strongly disagree, 5 = strongly agree)	3.64 (1.34)	3.33 (1.37)	3.75 (1.17)	3.88 (1.07)	3.86 (1.18)	1.64
	n = 81	*n* = 43	*n* = 84	*n* = 43	*n* = 85	df = (4,327)
Government education campaign (1 = strongly disagree, 5 = strongly agree)	3.58 (1.13)	3.51 (1.14)	3.75 (1.16)	3.84 (1.02)	3.82 (.99)	1.05
	n = 81	*n* = 43	*n* = 81	*n* = 43	*n* = 85	df = (4,328)
Mandate related						
Vote for candidate who supports mandate (1 = much less likely, 5 = much more likely)	**2.31** (**1.14**)	2.77 (1.09)	2.54 (1.25)	2.60 (1.21)	**2.85** (**1.21**)	2.41*
	n = 80	*n* = 43	*n* = 81	*n* = 42	**n = 85**	df = (4,326)
States should mandate (1 = strongly disagree, 5 = strongly agree)	**2.56** (**1.22**)	2.74 (1.11)	2.52 (1.31)	2.84 (1.36)	**2.99** (**1.31**)	1.88
	n = 81	*n* = 43	*n* = 81	*n* = 43	**n = 85**	df = (4,328)
Allow parents to refuse vaccine (Reverse coded: 1 = strongly agree, 5 = strongly disagree)	**1.90** (**1.01**)	2.52 (1.19)	2.12 (1.08)	2.05 (1.21)	**2.39** (**1.25**)	3.09*
	n = 81	*n* = 42	*n* = 81	*n* = 43	**n = 84**	df = (4,326)

Note: Overall *F*-test reflects ANOVA with all five conditions. *$p \leq .05$ (two-tailed). Bolded text indicates significant differences between negative and positive frames, $p \leq .05$ (two-tailed).

The results offer support that different frames can influence HPV vaccine effectiveness ratings. The positive framing not only resulted in more favorable ratings compared with negative frames, but also when it was compared with no specific effectiveness information. Similarly, the negative frame appeared to lower vaccine ratings compared to the control. In contrast to prior studies with mixed frames, order appeared to have a distinct effect, with the negative frame potentially exerting a stronger recency effect. Mixed frames that ended with the negative frame produced an average rating very similar to the purely negative frame, but the mixed frame that ended with a positive frame more closely resembled the control.

3.4. The influence framing on the vaccine as a prevention strategy

The next set of analyses considers whether framing results in differences in perceived vaccine effectiveness for preventing cervical cancer specifically, and attitudes toward the vaccine as a strategy to prevent cervical cancer. In line with the hypothesized results, participants agreed more that HPV vaccination was an effective cervical cancer prevention strategy in the positive condition ($M_{pos} = 3.86$, $SD_{pos} = .80$) compared to the negative condition ($M_{neg} = 3.59$, $SD_{neg} = .93$), $t(162) = 1.95$, $p \leq .05$. However, the omnibus test that considered all conditions was not significant, $F(4, 324) = 1.66$, *ns*. The attitude measure was comprised of two summed semantic differential responses: whether "vaccinating eligible girls and young women with the HPV vaccine as a way to prevent cervical cancer would be" bad/good and foolish/wise. The summed measure ($r = .91$, $p \leq .001$) ranged from 2 to 10 ($M = 7.81$, $SD = 2.06$). The attribute positive frame condition had a marginally higher average mean ($M_{pos} = 8.07$, $SD_{pos} = 2.03$) than the attribute negative condition ($M_{neg} = 7.49$, $SD_{neg} = 2.06$) for the summed attitude item, $t(160) = 1.82$, $p = .07$. Again, the omnibus test across the full set of conditions was not significant, $F(4, 318) = .94$, *ns*.

3.5. The influence of framing on vaccine-related intentions and policy support

Framing showed mixed results for the other outcome measures, but the overall pattern was that mandate-related items tended to show effects, while the other items did not (see Table 2). This was particularly true for the purely positive and negative frames.

It had been hypothesized that reading the positive frame compared to the negative frame would result in higher likelihood of vaccine recommendation for a daughter of a close friend or family member. There were no significant differences by condition for either item. Beliefs about whether parents should vaccinate their children and whether doctors should recommend the vaccine also did not show significant differences between the positive and negative frames, nor did non-mandate-related policy items.

Mandate-related ratings, on the other hand, differed based on whether participants had been exposed to positive or negative framing. Compared to the negative framing condition, those in the positive condition agreed more that "States should require girls to get the vaccine which prevents cervical cancer or HPV as a requirement for attending school" $t(164) = 2.19$, $p \leq .05$, however, the omnibus test for the five conditions was not significant $F(4, 328) = 1.88$, $p = .11$. Conversely, those who read the negative frame agreed more that "Parents should be allowed to say no to a school policy requiring the HPV vaccine" than those who read the positive frame, $t(158) = 2.78$, $p \leq .01$, and the omnibus test was significant $F(4, 326) = 3.09$, $p \leq .05$. Framing also affected reported likelihood of voting for a political candidate who proposed to make HPV vaccination a requirement for girls to attend school. Those in the positive condition reported higher average vote likelihood than those in the negative condition, $t(164) = 2.95$, $p \leq .01$ and this difference was also reflected in the omnibus test, $F(4, 326) = 3.06$, $p \leq .05$.

A question that arises is whether vaccine ratings acted as a mediator between the frame condition and the mandate policy beliefs. We explored this using a combined mandate scale that summed the three mandate-related measures (Cronbach's $\alpha = .75$). Regression analysis did not show evidence of mediation under Baron and Kenny's criteria [32]. Preacher and Hayes' macro for SPSS not only provides a Baron and Kenny type mediation analysis, the program also calculates a Sobel test of indirect effects that assumes a normal distribution and a non-parametric bootstrap test for indirect effects [33]. The analysis found indirect effects for the positive framing condition versus the other four conditions and for the negative framing condition versus the other four conditions. However, we advise caution in interpreting the mediation analysis. While the mediation using regression analysis accounts for the full range of conditions using dummy variables, the Sobel test considers each dummy variable separately (e.g. just negative frames versus other frames, positive frames versus other frames, control frames versus other frames, etc.), meaning that methods are not strictly parallel. Nevertheless, these analyses suggest some degree of mediation, though certainly not full mediation. For the positive predictor variable, the Sobel test showed a significant reduction in framing effect, after controlling for perceived vaccine effectiveness ($z = 2.22$, $p \leq .05$). Similarly, the non-parametric test for indirect effects gives a 95% confidence interval greater than zero ($.05 \leq 95\%CI \leq .46$). The negative frame predictor variable showed similar results, ($z = -2.03$, $p \leq .05$), ($-.39 \leq 95\%CI \leq -.04$). While the empirical findings do not support a strong mediation effect, the results suggest that perceived vaccine effectiveness, in combination with other factors, may account for the framing effect produced by the positive and negative attribute frames.

4. Discussion and conclusion

4.1. Discussion

The way an issue is covered can provide a "set of interpretative packages that give meaning to an issue" [34]. Particularly when a technology is new and people may not have much personal experience with it, media's coverage of negative and positive attributes or risks and benefits of a technology can play a role in setting an affective tone and influencing impressions of it [35]. This study extends what has been a robust theoretical finding in the attribute framing literature to HPV vaccination, a new technology that has the potential to reduce cervical cancer morbidity and mortality, and that has been extensively covered in the news. The experiment contributes to health communication literature by drawing on attribute framing theory to better understand how minimal differences in textual framing can influence perceived vaccine effectiveness. The study both experimentally controls and explicitly reports the information context. At the same time the manipulated information is ecologically valid in that it is the kind of information that is in the "real world" media environment and thus was part of the larger HPV news narrative.

However, there are some limitations to the analysis. Although the survey was designed to be a nationally representative sample, it is not actually nationally representative unless survey weights are applied. As a result, the sample from which we randomly assigned participants may not be exactly representative of the U.S. population. Another limitation is that the framing was specific to a particular time point. Therefore the findings and particularly, the effect size, may not replicate over time, particularly if coverage changes. However, the main effects of attribute framing on vaccine ratings has been relatively robust, in that the framing effect has been found for a number of health related situations [15]. Finally, while the framed information was the kind that is in news coverage of the vaccine, the experiment was a single exposure and a very minimal manipulation and likely does not reflect the way that information would be encountered in the world, where there might be multiple exposures and multiple types of valence frames about different attributes within the same article. Nevertheless, by experimentally manipulating effectiveness frames, this study provides support for the view that framing of vaccine effectiveness in the media can influence perceived vaccine effectiveness. This can happen even when the information is logically equivalent.

4.2. Conclusion

On average, people in the study who read the same background information, but were told that the vaccine was 70% effective rated the vaccine as more effective than those who read that the vaccine was 30% ineffective and than those who were provided with no specific effectiveness information. Furthermore, the difference in favorability between positive and negative frames extended beyond general vaccine ratings. Those who read about vaccine effectiveness agreed more that the HPV vaccine was an effective way to prevent cervical cancer. They tended to have a more positive attitude toward use of the vaccination as a way to prevent cervical cancer.

While the experimental manipulation did not show statistical effects for whether people said they would recommend the vaccine to a friend or family member who asked advice on vaccinating an eligible daughter, there were effects related to political preferences. The finding that that those who read the positive frame were, on average, more likely to say they would vote for a candidate for governor who proposed requiring vaccination for schoolgirls is particularly interesting in light of the ongoing controversy over legislation to mandate the HPV vaccine. It is true that even in the positive framing condition the mean was below three on a five-point scale. This indicated that the respondents in the positive condition were merely less negative in their likelihood of voting for the candidate, but still reported being less likely to vote for the candidate. At the same time, the negative frame appeared to exacerbate opposition. Although the issue of support for vaccine mandates is a complex one that undoubtedly is affected by many variables besides perceived vaccine effectiveness, the study does suggest that coverage of vaccine effectiveness may play a role in opinion about the issue.

The study also suggests that the order in which effectiveness information is presented has consequences. Those who read about vaccine ineffectiveness followed by vaccine effectiveness rated the vaccine more favorably than those who read the positive information first and then read the negative information. From a theoretical standpoint, this information should be considered in designing future framing studies. From a more applied standpoint,

it suggests that it might make a difference whether one begins by discussing what the HPV vaccine is effective in protecting against or with what the vaccine is ineffective against. Therefore, this study indicates that minimal changes in the way the HPV vaccine is described can have consequences for the way the vaccine is perceived.

4.3. Practice implications

Health practitioners should be aware of valence framing and that it can influence perceived vaccine effectiveness. The study suggests a recency effect, particularly for negative effectiveness information, indicating order effects. The study findings have implications for clinical pamphlets and other text-based information sources that present vaccine effectiveness information. Future research may want to consider whether a similar pattern of findings regarding vaccine ratings occurs in doctor–patient interpersonal communications regarding the HPV vaccine and whether attribute framing would produce changes in intention to obtain the HPV vaccine in women in the targeted audience.

Conflict of interest statement

None declared.

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