



Immunize the HPV Vaccine Rumors: Effects of Inoculation Messages and Tone of Voice on Parental Intention to Vaccinate Their Children

EunHae Park¹ · Seoyeon Kim² · Glen T. Cameron³

Accepted: 28 April 2022 / Published online: 21 June 2022

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2022

Abstract

The purpose of this study was to develop an effective health communication strategy to guide the decision-making process of parents considering getting their children HPV vaccines. Using inoculation theory and findings on tone of voice as theoretical frameworks, the present study conducted a 2 (message type: inoculation vs. supportive) × 2 (tone of voice: human voice vs. organizational voice) mixed experiment with a total of 231 U.S. parents (either mother or father of a child eligible for the HPV vaccine). The results revealed that HPV vaccination promotions based on the inoculation message were more likely to generate positive attitudes toward the vaccination, higher intention to vaccinate their children, and higher intention to spread positive word of mouth (WOM) about HPV vaccination. Also, HPV vaccination promotions in the human voice were likely to increase the WOM intention more than those in the organizational voice. In regard to an interaction effect, human voice turned out to be more effective than organizational voice to generate the WOM intention when it comes to supportive messages; inoculation-based messages were similarly effective across the human and the organizational voice condition.

Keywords Inoculation theory · Human voice · Tone of voice · HPV vaccine

Introduction

Human papillomavirus (HPV) vaccination is recommended for adolescents to prevent life threatening health consequences such as cancer. However, many parents choose not to vaccinate their children. Such vaccine avoidance has worsened since COVID-19 and the vaccination rates have remained below pre-pandemic levels [1]. Misinformation from the anti-vaccine movement is a primary source that hinders vaccination attempts [2–4] while increasing parents'

concern about HPV vaccines [5]. Despite the regulations on anti-vaccine posting on social media, it continues to affect people by raising issues via the internet [6].

To overcome these barriers, the present study identifies two message factors to help parents' HPV vaccine decision making: inoculation message and tone of voice. The study aims to test “immunization” effects against misinformation about HPV vaccines based on inoculation theory. Inoculation theory posits that presenting a warning about possible attack messages (e.g., anti-vaccine information) and a refutation (e.g., counter-argument against anti-vaccine information) will work as an antibody to protect people's stance on an issue [7].

As communication style can alter how people perceive a certain message [8], the current study tests the role of tone of voice (e.g., organizational voice vs. human voice) in delivering inoculation messages about HPV vaccine. To be specific, organizational voice refers to messages from a third person perspective with didactic tone while human voice uses first person perspectives based on a conversational tone. Prior research suggests the outperformance of human voice over organizational voice in increasing positive responses to messages.

✉ EunHae Park
epark@bsu.edu
Seoyeon Kim
skim139@ua.edu
Glen T. Cameron
camerong@missouri.edu

¹ The School of Journalism and Strategic Communication, Ball State University, 2000 W University Ave, Muncie, IN 47306, USA

² Department of Advertising and Public Relations, University of Alabama, Tuscaloosa, AL 35487, USA

³ Missouri School of Journalism, University of Missouri, Columbia, MO 65211, USA

Our findings from an experimental survey with a sample of 231 U.S. parents confirmed the positive contribution of inoculation-based messages to improving pro-vaccination perceptions and behavioral intentions as well as the out-performance of human voice in generating word-of-mouth (WOM) intention. These findings suggest communication practitioners to actively apply inoculation features in HPV vaccination campaign messages development, while further utilizing conversational tone of voice.

Literature Review

Inoculation Theory

The basic assumption of the inoculation theory is based on a typical inoculation process. For example, routine vaccinations in the clinical setting involve patients receiving a weakened dose of a virus (e.g., the flu vaccine) to produce an antibody that can protect their body against stronger versions of the virus (e.g., the flu). Similarly, McGuire [9] proposed an assumption that individuals can be inoculated against future attack messages regarding a given topic in much the same way individuals can be inoculated against a virus. In terms of communication process, pretreatment messages offer weakened versions of counterarguments, creating a “cognitive antibody” that can stimulate individuals’ intellectual defense system to overcome subsequent attack messages [7]. In the context of HPV vaccine issue, the pretreatment messages protect people from conflicting arguments about HPV vaccines such as rumors and misinformation.

The inoculation message consists of two main elements: forewarning and refutational preemption. Forewarning messages play a role in warning of some of the attack messages people may encounter about an issue. The forewarning message is presented before the refutational preemption to let people know about possible future attacks. For example, at the beginning of a vaccine promotional message, the message sender (e.g., CDC) warns that people may encounter anti-HPV vaccine information that are very persuasive, which will encourage people to think carefully about their own position toward the vaccine. By using forewarning, the inoculation message can elicit an essential part of the inoculation process—threat. Threat is defined as a feeling toward possible counterarguments people have [10] and is a starting point of the inoculation process that elicits motivation to defend people’s current attitude by counterarguing [9, 10].

Refutational preemption refers to specific content that receivers can employ to strengthen their attitudes against subsequent change [11]. Specifically, the refutational preemption not only presents the opposite side of the information, but also arguments and evidence that can be used to refute arguments presented in subsequent attack messages.

In terms of the HPV vaccine issue, refutational preemption messages point out the typical arguments of HPV vaccine opponents, such as HPV vaccine being unsafe based on vaccine-adverse cases. At the same time, the message provides information that can be used as a counterargument. For example, it might explain that the vaccine opponents’ data included health problems caused by conditions that were not directly linked to vaccines, and that more than 200 categories of side effects were tested and no correlation was found.

A typical experimental setup for testing the inoculation theory is comparing the inoculation messages with supportive messages. Supportive messages reflect one-sided information as opposed to the inoculation messages and it focuses only on bolstering information about an issue [12]. In terms of HPV vaccine, the supportive message can represent common HPV vaccine promotional campaigns by a manufacturer (e.g., GARDASIL) or by CDC. All information aims to reinforce positive aspects of an issue rather than altering to possible counterarguments. Therefore, given the fact that anti-vaccine messages are prevalent, it is a meaningful approach based on reality to test which of supportive message and inoculation message can help vaccine decision making more effectively.

Outcomes of Inoculation Messages: Attitudes and Behavioral Intentions

Early studies [7, 13, 14] and recent studies [15, 16] have found superior effects of inoculation messages on attitudes and behavioral intentions. For instance, Maertens et al. [15] found that inoculation messages promoted resistance to misinformation about climate change while it elicited more positive attitude and strong intention to follow inoculation messages than people who were exposed to supportive or no-treatment conditions.

Beyond attitude and intention, according to Compton and Pfau [17], inoculation treatments work at an interpersonal level and promote the intention to talk about the issue and the contents, which is known as word of mouth (WOM). Such theoretical implications have also been revealed in recent studies. For example, according to Clear et al. [18], people exposed to inoculation showed higher tendency to talk about the issue and contents while actively searching for additional information as a part of post-inoculation behaviors. Considering that WOM is one of the main factors influencing vaccine decisions [19], it is important to see whether inoculation messages increase WOM intention for vaccine contents delivered by health authorities.

The consistent and strong effect of the inoculation treatment provides a cue to assuming that the same effects can occur in the context of vaccine communication. Although studies comparing inoculation messages and supportive

messages about vaccines are rare, a study by Jolley and Douglas [20] found that using counter-argument function of inoculation theory is effective at increasing the intention to vaccinate children.

Based on the discussions above, the current study proposes the following hypothesis:

H1 HPV vaccine promotional messages delivered through inoculation messages will elicit (a) more positive attitude toward HPV vaccination, (b) higher intention to vaccinate one's child, and (c) higher intention to spread positive WOM about HPV vaccination, compared to supportive messages.

Tone of Voice

The topics above focused on the issue of what to deliver to target audiences, since providing appropriate message content is the starting point of health communication. At the same time, however, the method of delivery is as important as the content because it can alter the message effects. To answer the question of how to deliver a message, there are two considerations: (a) knowing the most preferred medium and (b) understanding the characteristics of that medium. By doing so, health practitioners can convey their message in the best possible way to influence people's perception.

In terms of health communication, the Internet is the most preferred medium for information seeking including vaccine information [21, 22]. One interesting aspect of online communication is that people expect to experience more interpersonal communication through the Internet than through traditional media [23]. The Internet's interactive functions (e.g., comments, feedback options) make people consider online communication as somewhat like having conversations with real people. Hence, the tone of voice has emerged as a crucial part of online communication [24, 25].

According to previous studies on online communication, there are two types of tone of voice: conversational human voice and organizational voice. The major difference between the two is whether the provided content is based on a conversational format in the first person (human voice) or based on a third person account (organizational). Specifically, the strategy of using human voice gives the message an interpersonal tone by focusing on the first person's perspectives and addressing personal anecdotes to "convey some sense of human attributes existing behind an organizational facade" ([26], p. 409). By doing so, the perceived conversational human voice is enhanced, which can lead to a more positive attitude toward an organization or an issue. In contrast to the human voice strategy, organizational voice solely depends on a third person perspective and straightforward facts.

The effect of tone of voice was tested in several previous studies in public relations [27], marketing [28] and

crisis management [24, 29]. Although the academic backgrounds of the studies are somewhat different, all of them found consistent superior effects of conversational human voice on attitude toward an organization [29]. The reason is that the human voice strategy generates perceptions of transparency and openness in an organization's dialogue with its public [30]. Furthermore, the positive impression of communication makes people satisfied with their relationships with the organization online [26, 31, 32], which leads strong intention to engage in WOM communication about the organization in a positive way [27].

Even in crisis cases, where there can be conflicting opinions on an issue that can have a negative impact on the organization, human voice mitigates the negative attitude people have and moderates the effects of crisis response strategies from organizations [24]. The previous outcome is meaningful for vaccine communication as well, given the fact that the vaccine issues have similarities with crisis cases. For instance, the HPV vaccine issue is based on conflicts, which may result in negative impressions toward the issue, as in crisis cases. Although empirical studies investigating a link between tone of voice and vaccine information processing are rare, the consistent previous outcomes related to tone of voice provide a reasonable foundation to assume this link.

Based on the discussions above, the current study proposes the following hypothesis and research question:

H2 HPV vaccine promotional messages that are delivered through human voice will elicit (a) more positive attitude toward HPV vaccination, (b) higher intention to vaccinate one's child, and (c) higher intention to spread positive WOM about HPV vaccination, compared to messages delivered through organizational voice.

RQ1 Are there any interaction effects between message type (inoculation message vs. supportive message) and tone of voice (human voice vs. organizational voice) on (a) attitude toward HPV vaccination, (b) intention to vaccinate one's child, and (c) intention to spread positive WOM about HPV vaccination?

Method

A 2 (message type: inoculation vs. supportive message) × 2 (tone of voice: human vs. organizational voice) mixed experiment was conducted, with message type being a between-subjects factor and tone of voice being a within-subjects factor. A total of 231 U.S. parents, either mother or father of a child eligible for the HPV vaccine, were recruited, as the actual decision makers regarding HPV vaccination would be

Table 1 The demographics of participant parents

	<i>N</i>	%	<i>M</i>	<i>SD</i>
Gender				
Female	144	62.6		
Male	86	37.5		
Race/ethnicity				
Caucasian	183	79.2		
African American	18	7.8		
Hispanic	12	4.8		
Asian	11	4.8		
Native American	2	0.7		
Pacific Islander	1	0.3		
Another	4	1.4		
Age				
Participants			42.43	8.69
Participants' children			15.28	3.92

parents [33]. Amazon's Mechanical Turk (MTurk), a web-based platform for participants recruiting, was used and each participant was given 1.10 U.S. dollars as compensation. Table 1 illustrates the demographic information of the participants.

Procedure

An online experimental survey was conducted. Participants who consented to participate in the study were randomly assigned to either the inoculation or the supportive message condition. The participants' pre-existing attitudes toward HPV vaccination and their perceived trustworthiness of the government handling the HPV vaccine issue were measured. Each participant then read either two inoculation-based or two supportive HPV vaccination promotional messages, one written in the human voice and another in the organizational voice (see Table 2 for experimental conditions). To reduce influence a single particular message topic may exert in participant reactions, two most common HPV vaccine related topics (e.g., vaccine safety issue vs. sexual inactivity of kids) were used. Manipulation check questions were followed. Then the participants read a separate attack message on the topic of vaccine safety and another on the topic of HPV vaccination during the early adolescence and answered questions to assess the dependent variables. At the end of the survey, demographic

information including gender, age, children's age, and political affiliation was collected.

Stimulus Messages

Stimulus messages were developed based on facts about HPV vaccination found on the websites of the CDC, the National Institutes for Health (NIH) and previous studies. The messages were consistent in terms of the overall format, flow, and length across the experimental conditions.

Message Type

Based on the prior studies [34, 35], inoculation messages provided a forewarning which lets the reader know about the existence of potentially persuasive anti-HPV vaccination perspectives. The forewarning message warned that some of the information people were likely to face on the HPV vaccine issue would be "very persuasive, and they might cause them to question their own position to vaccinate their children".

The refutational preemption messages introduced evidence-based refutations against anti-HPV vaccination messages. For instance, in terms of the HPV vaccine safety issue, the message pointed out that vaccine opponents claim that data shows the HPV vaccine may cause serious side effects leading to hospitalization or life-threatening events. Along with the argument, the message provided refutations explaining that more than 200 categories of side effects have been examined, and no clear evidence supporting the opponents' arguments was found.

Supportive messages focused on bolstering the beneficial aspects of the HPV vaccine. Hence, the messages emphasized that the HPV vaccine is effective and safe. For the supportive message conditions, there was no additional information such as forewarnings and refutations.

Tone of Voice

Mock web pages of the CDC were created to deliver the message stimulus in either human or organizational voice. Based on Kelleher's [31] conceptualization of human voice, web pages using human voice were written in the first person (i.e., "I would like to let you know that HPV vaccination has been shown to be very effective") and provided the speaker's mock blog to make an impression of personal conversation. Contrary to the human voice condition, using an organizational voice

Table 2 Assignments of participants

Condition 1: inoculation message (n = 111)		Condition 2: supportive message (n = 120)	
Human voice	Organizational voice	Human voice	Organizational voice
On the topic of either HPV vaccine safety or HPV vaccination available during the early adolescence		On the topic of either HPV vaccine safety or HPV vaccination available during the early adolescence	

provided the same information in the third person perspectives (i.e., “CDC announces that HPV vaccination has been shown to be very effective”) and provided official website address. All the information stated in the message was the same across experimental conditions, but the tone of voice was manipulated.

Attack Messages

Attack messages (anti-vaccine information; e.g., serious side effects of HPV vaccines) were presented after the vaccination promotional message to see if participants in inoculation conditions reacted differently than those in supportive conditions. Attack messages were created based on vaccine opponents’ arguments found online.

Measures

Attitude Toward HPV Vaccination

A 7-item semantic differential scale was used, anchored by the following bipolar adjective pairs [36, 37]: bad/good, harmful/beneficial, foolish/wise, threatening/assuring, and risky/safe ($\alpha=0.97$).

Intention to Vaccinate One’s Child

To measure how likely the participants were to vaccinate their children after reading the stimuli, three items on a 7-point bipolar scale adapted from Abhyankar et al. [36] were used (e.g., “I intend to vaccinate my child against HPV”) ($\alpha=89$).

WOM Intention

The current study used four items (e.g., “I would encourage family members or relatives to get HPV vaccines;” “I would encourage friends to get HPV vaccines”), which were derived from Brown et al. [38], to measure intention to spread positive WOM about HPV vaccination (1 = extremely unlikely, 7 = extremely likely) ($\alpha=0.92$).

Control Variables

Perceived trustworthiness of the government handling the HPV vaccination, political affiliation, and prior attitudes toward HPV vaccine served as control variables. The level of trust in government was measured by using seven 7-point Likert scale items ($\alpha=0.93$) derived from Myers [39].

Political affiliation was measured by using a 7-point Likert scale (1 = very conservative, 7 = very liberal) derived from [40]. Prior attitude toward HPV vaccination was measured based on the same scale addressed above to measure attitude. Each variable was controlled as prior research has found a negative association among political affiliation, trust in governments, prior attitudes, and vaccine decision [40–42].

Results

Manipulation Check

Message Type

Participants were asked about whether or not the message provided information about counter arguments against HPV vaccine and refutations on a 7-point scale ranging from 1 (not at all) to 7 (very much). Participants perceived inoculation messages as providing forewarnings and refutations ($M=5.26$, $SD=0.7$) more than supportive messages ($M=2.73$, $SD=0.7$), $t(14)=10.71$, $p<0.05$.

Tone of Voice

Nine items were derived from Kelleher and Miller [26] and asked how participants perceived the tone of voice embedded on the given message on a 7-point Likert scale ranging from strongly disagree (1) to strongly agree (7) (e.g., “this web page invites people to conversation,” “this web page is open to dialogue”) ($\alpha=83$). The results indicated that manipulation of tone of voice was successful, $F(1,229)=2284.46$, $p<0.05$, as the human voice condition produced a higher level of perception of conversational voice ($M=4.81$, $SE=0.05$) than the organizational voice condition ($M=3.82$, $SE=0.06$).

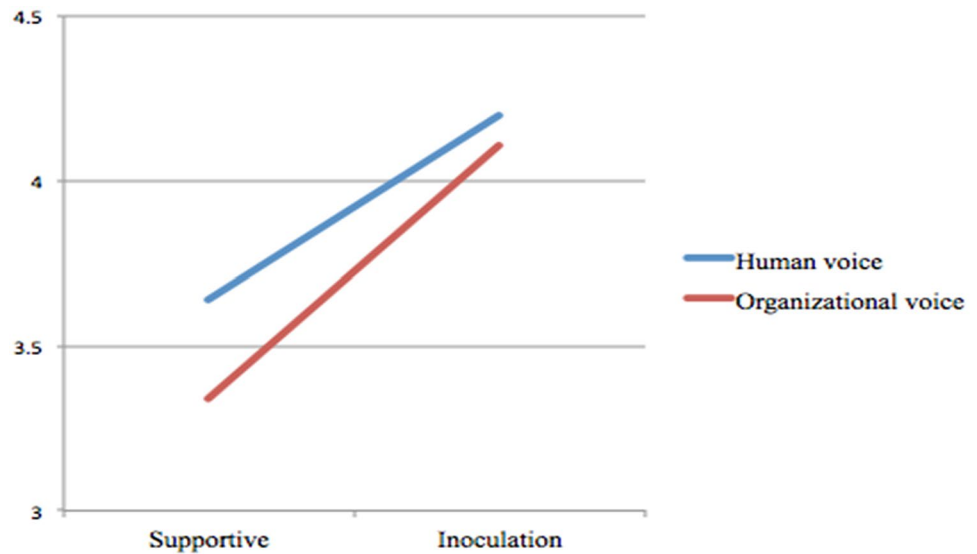
Hypothesis and Research Question Tests

To test the proposed hypotheses and research questions, a series of repeated ANCOVA was performed, with prior attitude toward HPV vaccination, political affiliation, and perceived trustworthiness of government serving as covariates.

H1 was supported. There were significant main effects of message type on attitude toward HPV vaccination, $F(1,228)=8.48$, $p<0.05$, $\eta^2=0.03$, intention to vaccinate one’s child, $F(1,228)=8.26$, $p<0.05$, $\eta^2=0.02$, and intention to spread positive WOM about HPV vaccination, $F(1,228)=9.48$, $p<0.05$, $\eta^2=0.04$. HPV vaccine promotions delivered through inoculation messages would lead to (a) more positive attitude toward HPV vaccination, (b)

Table 3 Means of dependent variables across message types

	Inoculation message <i>M (SD)</i>	Supportive message <i>M (SD)</i>
Attitude toward vaccination	4.60 (0.14)	3.98 (0.14)
Intention to get one's child vaccinated	4.22 (0.15)	3.76 (0.15)
Intention to spread positive word-of-mouth (WOM)	4.15 (0.15)	3.49 (0.14)

Fig. 1 Interaction of message type and tone of voice on word-of-mouth (WOM) intention**Table 4** Means of word-of-mouth (WOM) intention across message types and tone of voice

	Inoculation message <i>M (SD)</i>	Supportive message <i>M (SD)</i>
Human voice	4.20 (0.16)	3.64 (0.15)
Organizational voice	4.11 (0.15)	3.34 (0.14)

higher intention to vaccinate one's child, and (c) higher intention to spread positive WOM about HPV vaccination, compared to supportive messages. Table 3 illustrates the findings of the results.

H2 was partially supported. The results showed a main effect of tone of voice only on intention to spread positive WOM about HPV vaccination, $F(1,228) = 5.01, p < 0.05, \eta^2 = 0.02$. The human voice condition generated a higher level of WOM intention ($M = 3.92, SE = 0.11$) than the organizational voice condition ($M = 3.72, SE = 0.10$). There were no significant main effects found on attitude toward HPV vaccination and intention to vaccinate one's child.

RQ1 asked if there would be interaction effects between message type (inoculation vs. supportive) and tone of voice (human voice vs. organizational voice) on the dependent

variables. There was a significant interaction effect on intention to spread positive WOM about HPV vaccination, $F(1,228) = 11.16, p < 0.05, \eta^2 = 0.04$. In the inoculation message condition, there was no difference in the WOM intention between the human-voiced and the organization-voiced message. However, in the supportive message condition, the human-voiced message was more effective to generate the WOM intention than the organization-voiced message (see Fig. 1 and Table 4). No significant interaction effects were found on attitude toward HPV vaccination and intention to vaccinate one's child.

Discussion

The purpose of this study was to develop a communication strategy to help parents resist the persuasive conflicting information about HPV vaccination. To do so, the present study tested the effects of inoculation and supportive messages. Also, this study tested the impact of tone of voice (i.e., human voice vs. organizational voice) on parents' HPV vaccination-related perceptions and behavioral intentions.

First, the present study showed that inoculation messages can have positive effects on target audiences' perceptions and behaviors regarding controversial health issues like HPV

vaccination. In the past, the inoculation theory was mainly used for pure topics centered on cultural truism (e.g., brushing teeth is good) to follow the biological analogy proposed by McGuire [9]. However, in the current situation where various information is easily shared, an important question is whether the theory will be effective even when people have mixed perceptions toward an issue such as vaccination. As if reflecting this research agenda, ‘therapeutic’ aspect of inoculation theory is being emphasized [10] and the results of this study confirmed such effects of the theory in the controversial issue. Not only that, given that misinformation about vaccines has been more pervasive than ever before since the COVID-19 pandemic broke out, more active use of inoculation message features is called for in vaccination campaigns development [6, 43].

Another theoretical implication of this study is that it tested a moderating variable that has not yet been studied in various ways in the examination of inoculation theory: tone of voice. The need for research on diverse variables to suggest directions of the theory has been continuously raised [10], but the theoretical discussion reflecting the reality that most communication is conducted online has hardly progressed. Therefore, the use of tone of voice as a moderating variable, a common message characteristic strategically embedded in online communication, can be seen as laying the foundation for advanced use of the theory.

In addition, tone of the voice is a topic that has been mainly studied in public relations. For example, it has been researched for companies to make online communication more effective [24, 27]. By investigating the concept in a different area such as health communication, the theoretical implications of tone of the voice strategy were expanded, suggesting that the role of tone of the voice may vary depending on the subject [28]. Not only that, the main topic of health communication after COVID-19 was communication style in terms of how to deliver the content beyond what to deliver [44]. Because what the target public needs is not only information but also psychological connection with the authorities [45]. As human voice strategy is one of the effective online communication strategies that can increase engagement with the message sender, the study has led to an approach to communication style that should be discussed in the future in health communication.

The present study’s theoretical implications are also connected with practical suggestions. First, given that attitude and intention are powerful predictors of actual behaviors [46] including vaccination [47], the results suggest that inoculation messages can be an effective communication tactic to increase HPV vaccination rate among adolescents. Inoculation messages have not been utilized well in the real world of HPV vaccine promotions, as the most recent HPV vaccination promotional messages by the CDC, NIH, and even the vaccine manufacturers such as GARDASIL have

only relied on supportive messages. Those HPV vaccination promotional messages often emphasize the safety and effectiveness of the vaccine. However, such one-sided messages may lead people to become vulnerable to some convincing anti-vaccine contents [48]. Contrary to the current HPV vaccination promotional efforts, what the present study’s findings imply is that letting people know about possible counter-arguments they might encounter is a useful strategy to guide their HPV vaccination decision-making process.

Another interesting result is that the role of the human voice strategy revealed a clear difference in attitude toward self and others. For example, human voice strategy did not show a major influence on one’s own attitudes or intentions toward HPV vaccines unlike previous studies. The reason can be interpreted that the vaccine anxiety or risk perception people may have by reading an attack message dilutes the role of the voice. This phenomenon has been demonstrated in a recent study. According to Barcelos et al. [28], even people who responded positively to human voice messages may no longer be affected by the voice when they are exposed to negative information, which can cause risk perception toward a certain issue. Which means, in situations where there are many factors that cause risk perception such as vaccines, the role of the voice may appear differently.

On the other hand, HPV vaccine information written in human voice strategy led higher intention to share the message with others around them. In other words, voice is an important variable in information sharing for others. This can be seen as a result of the unique characteristics of vaccines and word-of-mouth communication. Specifically, vaccines are not only important to individuals, but are an issue related to the health and safety of people around and society as a whole. Therefore, it is highly likely that people feel social norm to inform others about vaccine information [49]. Given the fact that this social norm acts as a predator of word-of-mouth intention [50], it can be interpreted that the sense of duty to share information about vaccines can be triggered better by human voice than organizational voice.

Such a high viral-potential message strategy is important in vaccine communication because vaccine information transmitted through people around a person have a strong effect on the person’s vaccine decision [19]. Therefore, the results of this study revealed the crucial role of human voice strategy in vaccine communication and, interestingly, it could improve supportive messages’ effectiveness by increasing people’s intention to spread the information. As a result of the overall outcomes of the study, it suggests communication practitioners to actively apply inoculation features in HPV vaccination campaign messages development, while further utilizing conversational human voice in situations where general (non-inoculation) campaign messages are deemed more appropriate.

Future Research Suggestions

Taken together, the results of the study suggest that various moderating variables need to be tested in order to use the theory in reality. For example, making variations of inoculation and attack messages will provide the opportunity to expand the results of the present study. Current study used refutational messages and attack messages addressing the same topic to control confounding variables. But in reality, people are exposed to various conflicting messages about HPV vaccination (e.g., hearsay, conspiracy theories). Therefore, it is necessary to test whether refutational messages are effective in attack messages that talk about other issues to see blanket effects of inoculation [51].

The role of the information source that delivers the inoculation message and/or attack message is also worth discussing. People are surrounded by diverse sources, including health care practitioners, media, lay people, and expert patients. Among these sources, recent studies have found that people have a tendency to depend on narratives conveyed by lay people or patient experts [52], because these sources can share similar experiences and emotions with people. In particular, patient experts who already had a vaccine experience play a crucial role in leading the opinions of people who plan to vaccinate their children. In this regard, further research is needed with several variables mentioned above.

Funding The authors received no financial support for the research, authorship, and publication of this article.

Declarations

Conflict of interest Not applicable.

References

- Murthy, B. P., Zell, E., Kirtland, K., Jones-Jack, N., Harris, L., Sprague, C., Schultz, J., Le, Q., Bramer, C. A., Kuramoto, S., Cheng, I., Woinarowicz, M., Robison, S., McHugh, A., Schauer, S., & Gibbs-Scharf, L. (2021). Impact of the COVID-19 pandemic on administration of selected routine childhood and adolescent vaccinations—10 U.S. jurisdictions, March–September 2020. *Morbidity and Mortality Weekly Report*, *70*(23), 840–845.
- Argyris, Y. A., Kim, Y., Roscizewski, A., & Song, W. (2021). The mediating role of vaccine hesitancy between maternal engagement with anti- and pro- vaccine social media posts and adolescent HPV-vaccine uptake rates in the U.S.: The perspective of loss aversion in emotion-laden decision circumstances. *Social Science & Medicine*, *282*, 114043. <https://doi.org/10.1016/j.socscimed.2021.114043>
- Chen, L., Zhang, Y., Young, R., Wu, X., & Zhu, G. (2020). Effects of vaccine-related conspiracy theories on Chinese young adults's perceptions of the HPV vaccine: An experimental study. *Health Communication*, *36*(11), 1343–1353. <https://doi.org/10.1080/10410236.2020.1751384>
- Walker, K. K., Owens, H., & Zimet, G. (2020). “We fear the unknown”: Emergence, route and transfer of hesitancy and misinformation among HPV vaccine accepting mothers. *Preventive Medicine Reports*, *20*, 101240. <https://doi.org/10.1016/j.pmedr.2020.101240>
- National Cancer Institute (2021). Despite proven safety of HPV vaccines, more parents have concerns. Retrieved from <https://www.cancer.gov/news-events/cancer-currents-blog/2021/hpv-vaccine-parents-safety-concerns>
- Burki, T. (2020). The online anti-vaccine movement in the age of COVID-19. *The Lancet Digital Health*, *2*(10), 504–505. [https://doi.org/10.1016/S2589-7500\(20\)30227-2](https://doi.org/10.1016/S2589-7500(20)30227-2)
- McGuire, W. J. (1964). Introducing resistance to persuasion. *Advances in Experimental Social Psychology*, *1*, 191–229. [https://doi.org/10.1016/S0065-2601\(08\)60052-0](https://doi.org/10.1016/S0065-2601(08)60052-0)
- Wang, R., & Huang, Y. (2018). Communicating corporate social responsibility (CSR) on social media: How do message source and types of CSR messages influence stakeholder's perceptions? *Corporate Communications: An International Journal*, *23*(3), 326–341. <https://doi.org/10.1108/CCIJ-07-2017-0067>
- McGuire, W. J. (1961). The effectiveness of supporting and refutation defenses in immunizing and restoring beliefs against persuasion. *Sociometry*, *24*(2), 184–197. <https://doi.org/10.2307/2786067>
- Compton, J., Liden, S., Cook, J., & Basal, M. (2021). Inoculation theory in the post-truth era: Extant findings and new frontiers for contested science, misinformation and conspiracy theories. *Social and Personality Psychology Compass*, *15*(6), 1–16. <https://doi.org/10.1111/spc3.12602>
- Pfau, M., Bockern, S. V., & Kang, J. G. (1992). Use of inoculation to promote resistance to smoking initiation among adolescents. *Communications Monographs*, *59*(3), 213–230.
- Ivanov, B., Rains, S. A., Geegan, S. A., Vos, S. C., Haarstad, N. D., & Parker, K. A. (2016). Beyond simple inoculation: Examining the persuasive value of inoculation for audiences with initially neutral or opposing attitudes. *Western Journal of Communication*, *81*(1), 105–126. <https://doi.org/10.1080/10570314.2016.1224917>
- Pryor, B., & Steinfatt, T. (1978). The effects of initial belief level on inoculation theory and its proposed mechanisms. *Human Communication Research*, *4*(3), 217–230. <https://doi.org/10.1111/j.1468-2958.1978.tb00611.x>
- Ullman, W. R., & Bodaken, E. M. (1975). Inducing resistance to persuasive attack: A test of two strategies of communication. *Western Speech Communication*, *39*(4), 240–248. <https://doi.org/10.1080/10570317509373873>
- Maertens, R., Roozenbeek, J., Basol, M., & van der Linden, S. (2021). Long-term effectiveness of inoculation against misinformation: Three longitudinal experiments. *Journal of Experimental Psychology*, *27*(1), 1–16. <https://doi.org/10.1037/xap0000315>
- Williams, M. N., & Bond, C. M. (2020). A preregistered replication of “inoculating the public against misinformation about climate change.” *Journal of Environmental Psychology*, *70*, 101456. <https://doi.org/10.1016/j.jenvp.2020.101456>
- Compton, J., & Pfau, M. (2009). Spreading inoculation: Inoculation, resistance to influence, and word-of-mouth communication. *Communication Theory*, *19*(1), 9–28. <https://doi.org/10.1111/j.1468-2885.2008.01330.x>
- Clear, S. E., Dimmock, J. A., Compton, J., & Jackson, B. (2020). How do inoculation messages work? A two-study mixed-method investigation into inoculation mechanisms. *Asian Journal of Communication*, *31*(2), 83–104. <https://doi.org/10.1080/01292986.2021.1888306>

19. Jose, S. (2021). COVID vaccine and generation Z: A study of factors influencing adoption. *Young Consumers*, 23(1), 16–32. <https://doi.org/10.1108/YC-01-2021-1276>
20. Jolley, D., & Douglas, K. M. (2017). Prevention is better than cure: Addressing anti-vaccine conspiracy theories. *Journal of Applied Social Psychology*, 47(8), 459–469. <https://doi.org/10.1111/jasp.12453>
21. Ashkenazi, S., Livni, G., Klein, A., Kremer, N., Hallin, A., & Berkowitz, O. (2020). The relationship between parental source of information and knowledge about measles/measles vaccine and vaccine hesitancy. *Vaccine*, 38(46), 7292–7298. <https://doi.org/10.1016/j.vaccine.2020.09.044>
22. Bryan, M. A., Evans, Y., Morishita, C., Midamba, N., & Moreno, M. (2020). Parental perceptions of the internet and social media as a source of pediatric health information. *Academic Pediatrics*, 20(1), 31–38. <https://doi.org/10.1016/j.acap.2019.09.009>
23. Eginli, A. T., & Tas, N. O. (2018). Interpersonal communication in social networking sites: An investigation in the framework of uses and gratification theory. *Online Journal of Communication and Media Technologies*, 8(2), 81–104. <https://doi.org/10.12973/ojcm/2355>
24. Park, H., & Cameron, G. T. (2014). Keeping it real: Exploring the roles of conversational human voice and source credibility in crisis communication via blogs. *Journalism & Mass Communication Quarterly*, 9(3), 487–507. <https://doi.org/10.1177/1077699014538827>
25. Sweetser, K. D., & Kelleher, T. (2016). Communicated commitment and conversational voice: Abbreviated measures of communicative strategies for maintaining organization-public relationships. *Journal of Public Relations Research*, 28(5–6), 217–231. <https://doi.org/10.1080/1062726X.2016.1237359>
26. Kelleher, T., & Miller, B. M. (2006). Organizational blogs and the human voice: Relational strategies and relational outcomes. *Journal of Computer-Mediated Communication*, 1(2), 395–414. <https://doi.org/10.1111/j.1083-6101.2006.00019.x>
27. Oh, J., & Ki, E. (2019). Factors affecting social presence and word-of-mouth in corporate social responsibility communication: Tone of voice, message framing, and online medium type. *Public Relations Review*, 45(2), 319–331. <https://doi.org/10.1016/j.pubrev.2019.02.005>
28. Barcelos, R. H., Dantas, D. C., & Senecal, S. (2018). Watch your tone: How a brand's tone of voice on social media influences consumer responses. *Journal of Interactive Marketing*, 41, 60–80. <https://doi.org/10.1016/j.intmar.2017.10.001>
29. Park, H., & Lee, H. (2013). Show us you are real: The effect of human-versus-organizational presence on online relationship building through social networking sites. *Cyberpsychology, Behavior, and Social Networking*, 16(4), 265–271. <https://doi.org/10.1089/cyber.2012.0051>
30. Rawlins, B. (2008). Give the emperor a mirror: Toward developing a stakeholder measurement of organizational transparency. *Journal of Public Relations Research*, 21(1), 71–99.
31. Kelleher, T. (2009). Conversational voice, communicated commitment, and public relations outcomes in interactive online communication. *Journal of Communication*, 59(1), 172–188. <https://doi.org/10.1111/j.1460-2466.2008.01410.x>
32. Yang, S. U., & Lim, J. S. (2009). The effects of blog-mediated public relations (BMPR) on relational trust. *Journal of Public Relations Research*, 21(3), 341–359.
33. McRee, A. L., Reiter, P. L., & Brewer, N. T. (2010). Vaccinating adolescent girls against human papillomavirus—Who decides? *Preventive Medicine*, 50(4), 213–214. <https://doi.org/10.1016/j.ypmed.2010.02.001>
34. Basol, M., Roozenbeek, J., & van der Linden, S. (2020). Good news about bad news: Gamified inoculation boosts confidence and cognitive immunity against fake news. *Journal of Cognition*, 3(1), 1–9. <https://doi.org/10.5334/joc.91>
35. Ivanov, B., Dillingham, L., Parker, K., Rains, S. A., Burchett, M., & Geegan, S. (2018). Sustainable attitudes: Protecting tourism with inoculation messages. *Annals of Tourism Research*, 73, 26–34. <https://doi.org/10.1016/j.annals.2018.08.006>
36. Abhyankar, P., O'connor, D. B., & Lawton, R. (2008). The role of message framing in promoting MMR vaccination: Evidence of a loss-frame advantage. *Psychology, Health and Medicine*, 13(1), 1–16. <https://doi.org/10.1080/13548500701235732>
37. Nan, X., & Madden, K. (2012). HPV vaccine information in the Blogosphere: How positive and negative blogs influence vaccine-related risk perceptions, attitudes, and behavioral intentions. *Health Communication*, 27(8), 829–836. <https://doi.org/10.1080/10410236.2012.661348>
38. Brown, J., Broderick, A. J., & Lee, N. (2005). Word of mouth communication within online communities: Conceptualizing the online social network. *Journal of Interactive Marketing*, 21(3), 2–20. <https://doi.org/10.1002/dir.20082>
39. Myers, L. M. (2011). Georgians' trust in government and non-government spokespersons concerning H1N1 influenza. Thesis, University of Georgia
40. Nan, X., Daily, K., Richards, A., Holt, C., Wang, M. Q., Tracy, K., & Qin, Y. (2019). The role of trust in health information from medical authorities in accepting the HPV vaccine among African American parents. *Human Vaccines & Immunotherapeutics*, 15(7–8), 1723–1731.
41. Paul, E., Steptoe, A., & Fancourt, D. (2020). Attitudes towards vaccines and intention to vaccinate against COVID-19: Implications for public health communications. *The Lancet Regional Health Europe*. <https://doi.org/10.1016/j.lanepe.2020.100012>
42. Suryadevara, M., Bonville, C. A., Cibula, D. A., Domachowske, J. B., & Suryadevara, A. C. (2019). Associations between population based voting trends during the 2016 US presidential election and adolescent vaccination rates. *Vaccine*, 37(9), 1160–1167.
43. Van der Linden, S., Roozenbeek, J., & Compton, J. (2020). Inoculation against fake news about COVID-19. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2020.566790>
44. Hyland-Wood, B., Gardner, J., Leask, J., & Ecker, U. K. (2021). Toward effective government communication strategies in the era of COVID-19. *Humanities & Social Sciences Communications*. <https://doi.org/10.1057/s41599-020-00701-w>
45. Porat, T., Nyrup, R., Calvo, R. A., Paudyal, P., & Ford, E. (2020). Public health and risk communication during COVID-19—Enhancing psychological needs to promote sustainable behavior change. *Frontiers in Public Health*. <https://doi.org/10.3389/fpubh.2020.573397>
46. Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211.
47. Wang, J., Zhu, H., Lai, X., Zhang, H., Huang, Y., Feng, H., Lyu, Y., Jing, R., Guo, J., & Fang, H. (2022). Vaccine uptake: A longitudinal study among Chinese adults after six months of a national vaccination campaign. *Expert Review of Vaccines*, 21(3), 385–395. <https://doi.org/10.1080/14760584.2022.2021076>
48. Okuno, H., Arai, S., Suzuki, M., & Kikkawa, T. (2022). Impact of refutation two-sided messages on attitudes toward novel vaccines against emerging infectious diseases during the COVID-19 pandemic. *Frontiers in Public Health*. <https://doi.org/10.3389/fpubh.2022.775486>
49. Korn, L., Bohm, R., Meier, N. W., & Betsch, C. (2020). Vaccination as a social contract. *Psychological and Cognitive Sciences*, 117(26), 14890–14899. <https://doi.org/10.1073/pnas.1919666117>
50. Han, H., Hwang, J., Lee, M., & Kim, J. (2019). Word-of-mouth, buying, and sacrifice intentions for eco-cruises: Exploring the function of norm activation and value-attitude-behavior. *Tourism Management*, 70, 430–443. <https://doi.org/10.1016/j.tourman.2018.09.006>

51. Ivanov, B., & Parker, K. A. (2020). Chapter 1. Inoculation theory as a strategic tool. In D. H. O'Hair & M. J. O'Hair (Eds.), *The handbook of applied communication research*. Wiley.
52. Bellander, T., & Landqvist, M. (2018). Becoming the expert constructing health knowledge in epistemic communities online. *Information, Communication, & Society*, 23(4), 507. <https://doi.org/10.1080/1369118X.2018.1518474>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.