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One HPV Vaccination Message Does Not Fit All: Differences Between Young Adults Deciding to Be Vaccinated and Parents Deciding for Their Children

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ABSTRACT

Despite decades of research on HPV vaccination, the U.S. has still not achieved optimal vaccination rates. This study investigated two different message strategies (agency assignment and deviance regulation marking) for encouraging HPV vaccination in two different populations: parents considering vaccinating their children and young adults (18–26) considering vaccinating themselves. Using a $2 \times 3 \times 3$ online experiment, this study examined the differences between the two message target groups and the effects of the different message strategies on psychological precursors to HPV vaccination and vaccination intention. The findings indicate that using both agency and deviance regulation marking message strategies provided a significant increase in HPV vaccination intentions. However, there were many differences in terms of the variables influencing HPV vaccination decision making in young adults (18–26) and parents making decisions for their children. Specifically, using human agency and a deviance message increased HPV vaccine confidence in young adults, but did not in parents. Implications of these findings for designing different messages directed to these target groups along with future directions are discussed.

HPV vaccination rates among children and young adults in the United States have gradually increased since the vaccine's introduction in 2006 but stagnated during the pandemic (Harris, 2024). Recent data indicate that the HPV vaccination uptake among adolescents aged 13–17 is below the US goal of 80% coverage, with approximately 70% receiving at least one dose, and significant, persistent disparities among certain demographic groups and regions (Pingali et al., 2022). Among young adults aged 18–26, uptake rates remain lower, with only about 40% completing the recommended vaccination series (Harris, 2024). Efforts by healthcare providers, public health campaigns, and educational initiatives have contributed to raising awareness about the importance of HPV vaccination in preventing certain types of cancers. However, despite the availability of safe and effective vaccines, misinformation and vaccine hesitancy continue to pose challenges in achieving optimal coverage (S. E. MacDonald et al., 2023). Ongoing efforts to address these barriers through targeted interventions, community engagement, and comprehensive education are crucial to further improving HPV vaccination rates and reducing the burden of HPV-related diseases in the population (Escoffery et al., 2023).

Text message reminders have emerged as a promising tool for encouraging HPV vaccination uptake among parents and young adults (Khuwaja & Peck, 2022). Recent research has demonstrated their effectiveness in improving vaccination rates by providing timely and personalized reminders to individuals and caregivers. Rand et al. (2020) found that text message reminders significantly increased HPV vaccination initiation and completion rates among adolescents, particularly in populations with historically lower vaccination rates. Similarly, a systematic review by Choi et al. (2023) highlighted the positive impact of text message reminders on vaccination adherence across various age groups and geographic regions. These findings underscore the role of text message reminders as a convenient and cost-effective strategy for promoting HPV vaccination and overcoming barriers, such as forgetfulness and lack of awareness.

Incorporating persuasion and social influence strategies into text message reminders can increase motivation and engagement to be vaccinated. For example, messages that highlight social norms by indicating that vaccination is a widely accepted behavior (Gerend et al., 2021), create a sense of urgency by mentioning limited vaccine availability (Escoffery et al., 2023), and empower individuals by attributing responsibility for vaccination decisions to them (McGlone et al., 2017), are likely to be more persuasive than others that do not refer to norms, availability, or personal responsibility.

This study tests the use of HPV vaccination message strategies in two different populations: young adults and parents making vaccination decisions for their children. We begin by reviewing the psychological literature that has consistently shown to predict HPV vaccination decisions. We then build a rationale for how message strategies can provide additional influence.

We investigated the impact of two distinct persuasion strategies – agency assignment and deviance regulation marking – on the effectiveness of text message reminders for promoting HPV vaccination directed toward parents of eligible children and to young adults. These strategies were chosen based on

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previous research showing their promise in vaccine promotion and because the strategies can be easily implemented in short messages of the sort used in SMS and social media posts. Agency assignment involves attributing responsibility or control over a situation to a specific entity or individual, while deviance regulation marking emphasizes the consequences of deviating from health behavioral norms. We justify these message experiments later in the literature review, but we begin by examining the psychological variables shown to play a key role in shaping vaccination intentions.

Psychometric predictors of vaccination intent

Vaccination intent is driven by a wide range of factors, categorized into complacency, constraints, and confidence (Betsch et al., 2018; N. E. MacDonald & The Sage Working Group on Vaccine Hesitancy, 2015; The SAGE Vaccine Hesitancy Working Group, 2014). Vaccine complacency occurs when vaccine-preventable diseases are perceived as low-risk, and vaccination is not a necessary preventive action (N. E. MacDonald & The Sage Working Group on Vaccine Hesitancy, 2015; The SAGE Vaccine Hesitancy Working Group, 2014). This study examines how the *risk perception of HPV* affects vaccination intention, to understand how complacency affects vaccination intent. Vaccine constraints measure the availability, affordability, accessibility, and comprehensibility of immunization services, and physical, structural, and psychological barriers to the services (Betsch et al., 2018). Vaccine constraints are related to *self-efficacy* (the ability to take action to be vaccinated), which can impact the degree to which constraint determines vaccination intent. Confidence is defined as trust in the effectiveness and safety of vaccines, the healthcare system, and the policy-makers (N. E. MacDonald & The Sage Working Group on Vaccine Hesitancy, 2015; The SAGE Vaccine Hesitancy Working Group, 2014). We assess confidence by incorporating *vaccination confidence* and *knowledge about HPV and HPV vaccines* as predictors of vaccination intent. In the next paragraphs, we introduce risk perception, self-efficacy, vaccination confidence, and knowledge as important psychological predictors of vaccination intention.

Risk perception consists of two dimensions: deliberative risk perception – i.e., the logical judgment of risk, such as the severity of the risk consequences (Ferrer & Klein, 2015; Wilson et al., 2019) – and affective risk perception, is the affective or emotional response to the risk, such as anxiety and worry (Ferrer & Klein, 2015; Wilson et al., 2019). Meta-analyses demonstrate that risk perception is positively related to vaccination and can increase vaccination behaviors against influenza and other diseases (Brewer et al., 2007; Weinstein et al., 2007). Here, we operationalize risk perception as the perceived severity of the threat posed by HPV and the effect of contracting HPV.

Another important predictor is self-efficacy, the belief that one can successfully enact a specific action (Bandura, 1997) in this case, a belief that one is able to get vaccinated. People with higher self-efficacy have lower expectations about barriers and are more confident in achieving goals, and thus have higher behavioral intentions (Vries et al., 1988). Studies have found that people with higher self-efficacy will more actively engage in positive health behaviors (Sheeran et al., 2016).

Vaccination confidence is also an important predictor of HPV vaccination intention. General vaccination confidence is the trust in the safety and effectiveness of vaccines (Betsch et al., 2018). Recent research examining HPV vaccination has found two components important to consider and they include general confidence as well as specific HPV vaccination confidence. Both forms of vaccination confidence are consistently strong predictors of vaccination intentions and often account for between 40 and 60% of the variance explained (Holman et al., 2014).

The final predictor considered in this study is HPV-related knowledge. When people have more knowledge about the risk, they can better interpret health messages and thus better understand the benefits of health actions (Reyna, 2012). Taken together, the explanatory value of these variables informs our first hypothesis:

H1. The perceived severity of HPV, affect about contracting HPV, self-efficacy about HPV vaccination, confidence in the HPV vaccine and in vaccines in general, and HPV-related knowledge are positively related to vaccination intention.

Parent vs. young-adult differences in vaccination decision making

Most of the current research on HPV vaccination focuses on understanding and designing messages for parents, because they are typically making the vaccination decisions for their children (Bednarczyk et al., 2023). However, this vaccine is recommended for people up to the age of 26 (Harris, 2024), and it is important to understand how young adults 18–26 make these decisions for themselves. Research has found that people are more likely to make active risk-reducing decisions for others than for themselves (Polman, 2012a, 2012b; Zilkmund-Fisher et al., 2006). For example, people have higher vaccination intentions when they make decisions for their friends than when they decide for themselves (Stone et al., 2013). One study of 23 pro-vaccine parents discovered that these parents reported themselves to be well-informed about the vaccination knowledge, believed in scientific evidence to make decisions, and disapproved of other parents who deviated from the recommended vaccination schedule (Wang et al., 2015). Another study discovered that vaccine-hesitant or vaccine-refusing parents had more knowledge about vaccines after having kids, and believed that vaccines were effective in protecting their kids, but they were worried about vaccination companies and side effects as well (Rozbroj et al., 2020). Brunson (2013) investigated the cognitive mechanism of how parents make decisions about children's vaccination and found that after parents receive health information, they conduct a critical assessment of health action importance and source credibility, and then make decisions. These studies suggest, in general, parents are concerned about diseases and vaccination, can be knowledgeable about vaccination, and critically assess health decisions for their kids (see also Nan et al., 2015).

In contrast, research indicates that young adults without children are not as familiar with HPV vaccines as parents and

are less concerned about vaccination. One study of university students discovered that many had positive attitudes toward HPV vaccination but lacked detailed knowledge about HPV or the vaccine (Glenn et al., 2021). Young adults are less knowledgeable than their parents for several reasons. Culture reinforces parents' responsibility for ensuring their children's health and well-being, including vaccines (Dempsey et al., 2016). Parents also tend to have more experience than young adults in talking with healthcare providers during their children's routine checkups, prior vaccinations, etc. These interactions provide opportunities for parents to receive information and recommendations about the HPV vaccine from trusted sources (Gilkey et al., 2015). Parents are also more likely than young adults without children to be targeted by educational campaigns and interventions aimed at increasing HPV vaccine awareness and uptake. These campaigns often provide information about HPV-related diseases, the safety and efficacy of the vaccine, and the recommended age for vaccination. All of these factors can contribute to parents having greater exposure to HPV-related information compared to young adults without children. Given these factors and that knowledge about HPV and the vaccine is positively correlated with one's intention to seek vaccination (Dempsey et al., 2016), the following hypothesis was formulated:

H2. Parents have higher posttest vaccination intentions for their children than young adults do for themselves.

It is also important to understand how the psychological mechanisms present in prior studies of HPV vaccination might have different influences on parents vaccinating their children and young adults vaccinating themselves. Therefore, we pose the following research question:

RQ1. How do the psychological predictors of HPV vaccination intention vary between parents deciding to vaccinate their children and young adults vaccinating themselves?

Messages influencing decisions

Agency assignment

As health communication scholars, we are typically interested in moving beyond psychological predictors to understand how language and messages can impact behavior. Linguistic agency assignment refers to the entity portrayed as performing an action in a sentence (Dowty, 1991). In languages like English and Spanish, speakers have the grammatical flexibility to attribute agency for actions such as viral transmission either to the virus itself (e.g., *The virus could infect millions of people*) or to human agents (*Millions of people could contract the virus*). Despite their interchangeable usage, these assignments evoke distinct conceptualizations of transmission, portraying it either as an active pursuit by a predator or as a result of social contact within a person's control (McGlone et al., 2017). Research has demonstrated that patient education materials and vaccination policy arguments consistently assigning transmission agency to the virus (Covid-19, H1N1, HPV, influenza, etc.) tend to increase perceived threat severity and vaccination intentions compared to materials assigning agency to humans (Anthony et al., 2022; Bell et al., 2014a, 2014b; Ma & Miller, 2021; McGlone et al., 2013, 2017). Therefore, we make the following hypothesis:

H3. HPV vaccination reminder text messages using virus agency message strategies increase people's vaccination intentions relative to other agency assignments (human agency and no agency).

In accordance with the extended parallel process model (Witte, 1992), the predicted increase in vaccination intention is presumed to be predicated on appraisals of the same psychological predictors mentioned above: HPV threat severity and one's capacity to take this action (self-efficacy). In turn, these appraisals draw from one's knowledge about HPV and the vaccine that offers protection from it. Consequently, we sought to explore how the agency assignment manipulation influenced the relationship between these variables and vaccine intention. This line of reasoning motivated the following hypothesis and research question:

RQ2. How does agency assignment influence the relationship between vaccination intention and related psychological states?

Deviance regulation

The impact of messaging on behavior hinges critically on how individuals perceive the prevailing social norms related to that behavior. While people are generally inclined to adhere to social norms, their sense of individual identity stems from what they perceive about themselves as distinct from others. As posited by deviance regulation theory (Blanton & Christie, 2003; Ferrer et al., 2012), individuals tend to be more sensitive to the potential costs and benefits of deviating from perceived social norms than to conforming to them, particularly in situations where their behavior is deeply linked to their sense of self (e.g., during significant decision-making processes). Thus, messages aimed at influencing behavior are likely to have a greater impact when framed in terms of deviating from the norm rather than conforming to it. For instance, if a parent believes that most other parents vaccinate their children against HPV, they are likely to be more conscious of the "unusual" risks associated with not vaccinating, rather than the benefits of aligning with what they perceive as the norm. Conversely, if they perceive that most parents do not vaccinate their children, they may be more attentive to the relatively uncommon benefits of vaccination rather than the prevalent risks associated with non-vaccination.

The principles of deviance regulation theory have guided interventions targeting various behaviors, including reducing binge drinking and illegal drug use, promoting physical activity and safe sex practices, and increasing seasonal flu vaccination rates (Blanton & Christie, 2003; Dvorak et al., 2018; Ferrer et al., 2012; van Bavel et al., 2017). In our current study, we frame HPV vaccination as the norm and emphasize the risks of deviating from it. This stems from the assumption that a text message vaccination reminder from a healthcare provider would inherently position vaccination as the prevailing social norm (both descriptively and injunctively) among our participants, rather than abstention. This line of reasoning motivates the following hypothesis.

H4. HPV vaccination reminder text messages that characterize vaccination as the norm increase people's vaccination intentions relative to other deviance regulation markings (vaccination as the deviance and not mentioning norms).

In addition, we are interested in how the deviance regulation marking manipulation might influence the relationship between vaccination intention and psychological states presumed to motivate intention. Therefore, we ask the following research question:

RQ3. How does deviance regulation marking influence the relationship between vaccination intention and related psychological variables?

Method

Participants

862 paid volunteers were recruited to participate in the study via the online audience panel platform *Centiment* (www.centiment.co). The sample consisted of two groups of adults who were U.S. residents and fluent English speakers. Because the focus is on the vaccine decision maker, volunteers for the first group were required to be parents or guardians of a child 17 or under who had not been vaccinated for HPV. Volunteers for the second group were required to be between the ages of 18 and 26 and to have not yet been vaccinated for HPV. We invited volunteers who met the aforementioned criteria to participate in an online message testing experiment. Each participant who completed the experiment was compensated according to their agreement with Centiment. The choice of sample size was directed by power analytic considerations, with a targeted power of .85 for detecting predicted effects that would account for 5% explained variance, applying two-tailed tests with a nondirectional alpha of .05.

We used a rigorous attention check procedure that mirrored a thought-listing exercise (Cacioppo et al., 1997), where participants were asked to type three words that came to mind when thinking about HPV vaccination. If the words were not logical or were repeated words, those participants were removed from the sample. We also checked for straight line responses and after removing the participants who failed these attention checks, 718 remained. Parent participants' ages ranged from 22 to 60 years ($M = 41$, $SD = 8.0$) and young adult participants' ages ranged from 18 to 26 years ($M = 22$, $SD = 2.5$). The demographic profile of the sample ($N = 718$) is shown in Table 1. The majority of the sample were female (52.4%), White (59.7%), non-Hispanic (74.4%), and employed full-time (54.3%). Most participants reported they had a health insurance plan (92.3%), had not been diagnosed with HPV (89.0%), and had not discussed HPV (50.7%) or the HPV vaccine (53.6%) with their healthcare provider.

Experimental design and procedure

This experiment employed a 2 × 3 × 3 factorial design with target group (parent or young adult), agency assignment (none, human, or virus) and deviance regulation marking (none, deviance, or norm) as between-subject factors. After providing informed consent and reading a brief procedural overview, participants were randomly assigned to one of the 18 message conditions (9 for parents and 9 for young adults, see Table 2). Participants were informed that the presented message "is a reminder you might receive from a healthcare provider to arrange a vaccination appointment for your child/yourself." To ensure the attention of participants, participants had unlimited time to review the message, but were required to spend a minimum of 20 s reading it before proceeding to the subsequent page. After reviewing the message, participants responded to attention-check questions, which were relevant to the presented content. Next, participants answered their psychological, demographic, and health-related data. After completion of the post-message questions, participants were presented with a short debriefing statement describing the purpose of the experiment. On average, participants spent 10.7 mins ($Median = 7.6$, $SD = 24.6$) completing the full experimental procedure.

Message stimuli

All participants read a message notifying them about the eligibility of their child or themselves for HPV vaccination and encouraging them to initiate the series. These messages were designed to be sufficiently brief for delivery on a text message vaccination reminder system (Khuwaja & Peck, 2022). Each message began with a greeting indicating the eligibility for vaccination (*Your child is/You are) due for the first dose of the Human Papillomavirus (HPV) vaccine*) and ended with a clinic contact (*Call the clinic at XXX-XXX-XXXX*). Control messages (for both parents and young adults) consisted only of these two sentences, while experimental messages also presented influence features (agency assignment and deviance regulation marking). Each experimental message contained one of three forms of the two message features (3 × 3 conditions listed in Table 2). An example experimental message is presented in Figure 1.

Agency assignment

There were three forms of this message feature: human, virus, and none (control). The "human" form attributed causality for HPV infection and its consequences to the human (*Your child/You could get HPV and increase their/your chances of developing several forms of cancer*). The "virus" form attributed causality and consequences to the virus (*HPV could infect your child/you and increase their/your chances of developing several forms of cancer*). The control form did not include these sentences.

Deviance regulation marking

There were three forms of this message feature: deviance, norm, and none (control). The "deviance" form conveyed that vaccination was an uncommon option and described the comparative benefit of deviating from this norm (*Vaccinating your child/yourself gives them/you protection other children/others around her/you don't have*). The "norm" form conveyed that vaccination was the most common option and described the comparative risk of deviating from this norm (*Not vaccinating your child leaves them unprotected compared to other children around her/Not getting vaccinated for HPV leaves you unprotected compared to other young adults around you*). The control form did not include reference to a vaccination or abstention norm.

Table 1. Demographic characteristics of sample ($N = 718$).

	Parents ($N = 376$)		Unvaccinated Young Adults ($N = 342$)	
Characteristic	*N*	Percentage	*N*	Percentage
Female	197	52.4%	176	51.5%
Male	178	47.3%	157	45.9%
Other/Prefer not to Answer	1	0.3%	9	2.6%
Race				
African-American	69	18.4%	84	24.6%
Asian	19	5.1%	12	3.5%
White (Including Hispanic Whites)	237	63.0%	192	56.1%
Other/Prefer not to Answer	51	13.6%	54	15.8%
Culturally or Ethnically Hispanic				
Yes	93	24.7%	91	26.6%
No	283	75.3%	251	73.4%
Marital Status				
Married	215	57.2%	33	9.6%
Not Married but in a Committed Relationship	53	14.1%	102	29.8%
Separated	15	4.0%	11	3.2%
Divorced	31	8.2%	3	0.9%
Widow/Widower	6	1.6%	2	0.6%
Never Married	56	14.9%	191	55.8%
Education				
Less Than High School Degree	5	1.3%	20	5.8%
High School Degree or Equivalent	74	19.7%	155	45.3%
Some College but no Degree	94	25.0%	79	23.1%
Associate Degree	56	14.9%	36	10.5%
Bachelor's Degree	92	24.5%	41	12.0%
Master's Degree	48	12.8%	9	2.6%
Doctorate Degree or Professional Degree	7	1.9%	2	0.6%
Employment				
Full-Time	255	67.8%	135	39.5%
Part-Time	36	9.6%	62	18.1%
Student	5	1.3%	52	15.2%
Unemployed and Looking for Work	30	8.0%	62	18.1%
Unemployed and Not Looking for Work	21	5.6%	17	5.0%
Other	29	7.7%	14	4.1%
Household Annual Income				
Less Than $20,000	41	10.9%	77	22.5%
$20,000–$39,000	78	20.7%	97	28.4%
$40,000–$59,000	56	14.9%	61	17.8%
$60,000–$79,000	70	18.6%	52	15.2%
$80,000–$99,000	45	12.0%	26	7.6%
$100,000–$119,000	23	6.1%	11	3.2%
$120,000 or More	63	16.8%	18	5.3%
Health Insurance Plan				
Employer Plan	214	56.9%	48	14.0%
Parent/Guardian Employer Plan	-	-	101	29.5%
Government Assistance Plan	127	33.8%	118	34.5%
Private Plan	23	6.1%	24	7.0%
No Plan	9	2.4%	46	13.5%
Other	3	0.8%	5	1.5%
Diagnosed with HPV				
Yes	50	13.3%	14	4.1%
No	321	85.4%	318	93.0%
Not Sure	5	1.3%	10	2.9%
Talked with Healthcare Provider about HPV				
Yes	199	52.9%	101	29.5%
No	158	42.0%	206	60.2%
Not Sure	19	5.1%	35	10.2%
Talked with Healthcare Provider about HPV Vaccine				
Yes	185	49.2%	95	27.8%
No	172	45.7%	213	62.3%
Not Sure	19	5.1%	34	9.9%

Measures

All items, unless stated differently, were measured using a seven-point Likert-type scale where 1 = very strongly disagree and 7 = very strongly agree. Please see Appendix for all items on the questionnaire instrument.

Severity

To measure participants' perceived severity of the threat posed by HPV, we used three items (McGlone et al., 2024). A sample item was *HPV is dangerous*. The Cronbach's α for the composite measure was .92 ($M = 5.3$, $SD = 1.6$).

Table 2. Factorial design used in experiment ($N = 718$).

Group	Target Group	Agency Assignment	Deviance Regulation marking	*N*
1 (Control)	Parent	None	None	39
2	Parent	Human	None	36
3	Parent	Virus	None	42
4	Parent	None	Deviance	38
5	Parent	Human	Deviance	46
6	Parent	Virus	Deviance	47
7	Parent	None	Norm	43
8	Parent	Human	Norm	44
9	Parent	Virus	Norm	41
10 (Control)	Young Adult	None	None	31
11	Young Adult	Human	None	35
12	Young Adult	Virus	None	48
13	Young Adult	None	Deviance	32
14	Young Adult	Human	Deviance	35
15	Young Adult	Virus	Deviance	43
16	Young Adult	None	Norm	28
17	Young Adult	Human	Norm	45
18	Young Adult	Virus	Norm	45

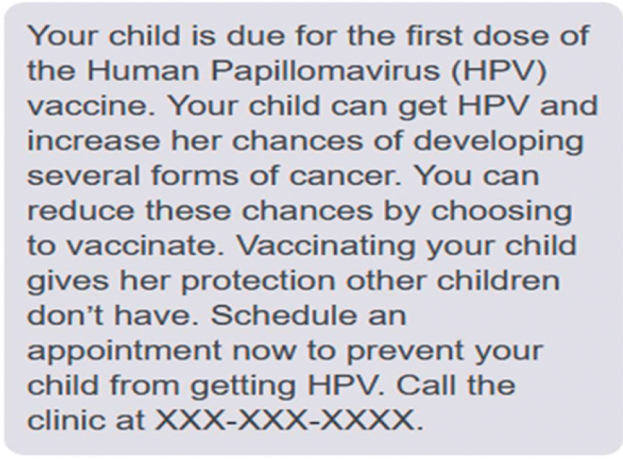

Figure 1. Example HPV vaccination reminder text message shown in study. This message condition represents a parent-targeted message with human agency and a deviance message. This study found that while this is a good message for young adults, it does not work well for parents.

Affect

To measure participants' affect about contracting HPV, we used five items (Wilson et al., 2019). A sample item was *I am concerned about my child contracting HPV* (for parents) or *I am concerned about contracting HPV* (young adults). The Cronbach's α for the composite measure was .95 ($M = 4.4$, $SD = 1.6$).

Self-Efficacy

Self-efficacy regarding HPV vaccination was measured using four items (McGlone et al., 2013). Sample items included: *I will be able to get both doses of the HPV vaccine for my child if I decide to do it* (for parents) and *I will be able to get both doses of the HPV vaccine if I decide to do it* (young adults). The Cronbach's α for the composite measure was .89 ($M = 5.0$, $SD = 1.4$).

HPV vaccine confidence

Participants' confidence in the HPV vaccine was measured using eight items (Gilkey et al., 2014). A sample item was *The HPV vaccine is safe*. The Cronbach's α for the composite measure was .86 ($M = 4.4$, $SD = 1.2$).

General vaccine confidence

General confidence in vaccines was measured using three items (Betsch et al., 2018). A sample item was *Vaccinations are effective*. The Cronbach's α for the composite measure was .91 ($M = 4.4$, $SD = 1.6$).

HPV-related knowledge

To measure participants' HPV-related knowledge, we used a seven-point Likert scale (1 = extremely unfamiliar to 7 = very familiar) with four items created for this study. A sample item was *How familiar are you with the HPV vaccine?* The Cronbach's α across all items was .93 ($M = 4.1$, $SD = 1.7$).

HPV vaccination intention

Intention about HPV vaccination was measured using two items (McGlone et al., 2017). A sample item was *If my healthcare provider recommends it, I will get the HPV vaccine for my child* (for parents) or *If my healthcare provider recommends it, I will get the HPV vaccine* (for young adults). The Cronbach's α for the composite measure was .90 ($M = 4.4$, $SD = 1.7$).

Results

Randomization check

We conducted a randomization check across the nine message assignment conditions. We used an ANOVA to analyze the age demographic, and chi-square tests to analyze other demographic and health status variables. Results revealed that there was no significant association between age ($F(8, 709) = .46$, $p = .86$), gender ($\chi^2 = 10.8$, $df = 8$, $p = .21$), race ($\chi^2 = 22.4$, $df = 24$, $p = .55$), being culturally or ethnically Hispanic ($\chi^2 = 13.6$, $df = 8$, $p = .09$), marital status ($\chi^2 = 39.0$, $df = 40$, $p = .51$), education ($\chi^2 = 49.8$, $df = 48$, $p = .40$), employment ($\chi^2 = 75.8$, $df = 88$, $p = .82$), household annual income ($\chi^2 = 39.2$, $df = 48$, $p = .81$), health insurance status ($\chi^2 = 26.1$, $df = 32$, $p = .76$), prior diagnosis with HPV ($\chi^2 = 9.5$, $df = 16$, $p = .89$), having talked with a healthcare provider about HPV ($\chi^2 = 3.3$, $df = 16$, $p = .92$), and having talked with a healthcare provider

about the HPV vaccine ($\chi^2 = 10.7$, $df = 16$, $p = .83$), and the nine message assignment conditions.

Main analyses

The means, standard deviations, and correlations of variables are shown in Table 3. These variables (affect, self-efficacy, HPV vaccine confidence, general vaccine confidence, HPV-related knowledge, and HPV vaccination intention) were all positively correlated to each other, with $p < .01$. The correlation results aligned with findings of previous studies (Bell et al., 2014a).

We used hierarchical multiple regression to test the hypotheses. In separate models (see Table 4), HPV vaccination intention was regressed on control (demographic and health-related), psychological, target group, message influence features, and interaction term variables. While there were no specific hypotheses for testing demographic and health-related variables, they have been shown to be significant predictors of vaccination intention in other studies (Caldwell et al., 2021; Holman et al., 2014). Therefore, in Model 1 ($F(6, 638) = 2.27$, $p = .04$, $R^2 = .012$), we tested the effects of people's demographic and health-related variables on their vaccination intentions. Results indicated that people who had a health insurance plan reported .09 higher vaccination intentions than others who did not ($t = 2.3$, $p = .02$), and people who had talked with their health provider about HPV reported .09 higher vaccination intentions than others who did not ($t = 2.2$, $p = .03$). Results indicated that being diagnosed with HPV or not, had no significant effect on people's vaccination intention ($t = 1.5$, $p = .12$).

In a test of Hypothesis 1, the psychological variables were entered into Model 2 ($F(12, 632) = 112.7$, $p < .0001$, $R^2 = .68$, $\Delta R^2 = .66$), resulting in a significant ($p < .001$) change in R^2 and partial support for that hypothesis. Results indicated that people's perceived severity about HPV ($\beta = -.02$, $t = 0.6$, $p = .56$) and knowledge about HPV and vaccine ($\beta = .00$, $t = 0.2$, $p = .86$) had no significant effect on their vaccination intentions. Results indicated that people's risk affect about contracting HPV ($\beta = .18$, $t = 6.2$, $p < .001$), self-efficacy ($\beta = .09$, $t = 3.1$, $p = .002$), confidence in HPV vaccines ($\beta = .29$, $t = 8.4$, $p < .001$), and confidence in vaccines ($\beta = .43$, $t = 13.5$, $p < .001$) had significant positive effects on their vaccination intentions. Thus, the results partially supported Hypothesis 1.

In a test of Hypothesis 2, the difference between a young adult's vaccination intention for themselves versus a parent's vaccination intention for their children, as well as its interactions with psychological variables, were entered into Model 3 ($F(19, 625) = 75.3$, $p < .0001$, $R^2 = .687$, $\Delta R^2 = .007$), resulting in a significant ($p = .001$) change in R^2, supporting H2. Results indicated that young adults' vaccination intentions for themselves were significantly lower than parents' vaccination intentions for their children ($t = -3.2$, $p = .001$), supporting H2. In addition, results indicated that the effect of vaccine confidence on vaccination intention for young adults was $\beta = .34$, which was significantly lower than for parents $\beta = .48$ ($t = 2.3$, $p = .02$). For young adults, the effect of HPV and vaccine knowledge on vaccination intention for young adults was $\beta = .05$, which was significantly different from the effect for parents $\beta = -.07$ ($t = 2.3$, $p = .02$). Being either a young adult or a parent did not significantly interact with other psychological variables on vaccination intention, $p > .05$ in all cases. The significant interaction effects between psychological variables and parent-young adult differences are shown in Figure 2.

In a test of Hypotheses 3 and 4, message influence features, i.e., agency assignment (none/human/virus) and deviance regulation marking (none/deviance/norm), and their interactions with psychological variables were entered into Model 4, ($F(47, 597) = 33.0$, $p < .0001$, $R^2 = .700$, $\Delta R^2 = .003$), resulting in a significant ($p = .002$) change in R^2. Results indicated that human agency ($t = 0.5$, $p = .63$) and virus agency ($t = 1.1$, $p = .26$) did not significantly affect vaccination intention, compared to the control. A post hoc ANOVA indicated that there was no significant difference in vaccination intentions among the three agency assignment groups ($F(2, 715) = .57$, $p = .56$). Thus, H3 was not supported.

Results indicated that the group vaccination as a deviance ($t = 1.0$, $p = .32$) and the group vaccination as a norm ($t = 0.3$, $p = .76$) had no significant effects on vaccination intention, compared with the control. A post hoc ANOVA indicated that there was not a significant difference in vaccination intentions among the three regulation markers ($F(2, 715) = .87$, $p = .42$). Thus, the results did not support H4.

The interaction analysis in Model 4 was conducted to address RQ2, and partially supported H5. Results indicated that the effect of severity on vaccination intention in the virus agency group was $\beta = .05$, which was significantly different from the no agency control group $\beta = -.14$ ($t = 2.6$, $p = .01$). Further inspection indicated that the effect of severity on vaccination intention was not significantly different between the virus and human agency groups, $\beta = .01$ ($t = .62$, $p = .54$). Results indicated that the effect of people's affect about HPV contracting on vaccination intention in the virus agency group was $\beta = .09$, which was significantly lower than in the no agency group $\beta = .24$ ($t = 2.1$, $p = .04$). Further inspection indicated that in the virus agency group, the effect was significantly lower than in the human agency group $\beta = .26$ ($t = -2.4$, $p = .02$), not supporting H5.

Table 3. Means, standard deviations, and correlations of psychological variables.

Variable	α	M	SD	1	2	3	4	5	6
1. Severity	.92	5.3	1.6						
2. Affect	.95	4.4	1.6	.45**					
3. Self-Efficacy	.89	5.0	1.4	.46**	.44**				
4. HPV Vaccine Confidence	.86	4.4	1.2	.41**	.59**	.61**			
5. General Vaccine Confidence	.91	4.4	1.6	.38**	.50**	.51**	.69**		
6. HPV-Related Knowledge	.93	4.1	1.7	.19**	.19**	.32**	.25**	.23**	
7. HPV Vaccination Intention	.90	4.4	1.7	.40**	.59**	.55**	.80**	.76**	.21**

**$p < .01$.

Table 4. Hierarchical multiple regression analysis for predicting vaccination intention from demographic, health-related, psychological, target and manipulated message influence variables.

Variables	Model 1 Demographic	Model 2 Psychological	Model 3 Target	Model 4 Message
F	2.27	112.7	75.3	33.0
df	(6, 638)	(12, 632)	(19, 625)	(47, 597)
p	.04	<.0001	<.0001	<.0001
R^2	.012	.675	.687	.700
R^2_{adj}	.021	.681	.696	.722
ΔR^2		.663***	.007***	.003**
Demographic and Health-Related Variables				
Sex	−.01	.01	.01	.01
Education	.04	.01	.00	.00
Household Annual Income	−.02	.00	.00	.00
Health Insurance Plan Status	.09*	.02	.01	−.00
Diagnosed with HPV	−.06	−.01	−.01	−.02
Talked with Healthcare Provider about HPV Vaccine	.09*	−.02	−.03	−.02
Psychological Variables				
Severity		−.02	−.03	−.14†
Affect		.18***	.19***	.24***
Self-Efficacy		.09**	.06	.01
HPV Vaccine Confidence		.29***	.35***	.40***
Vaccine Confidence		.43***	.48***	.48***
HPV and Vaccine Knowledge		.00	−.07†	−.08
Target Group				
Young Adult			−.17**	−.15**
Interactions: Psychological Variables × Target Group				
Severity × Young Adult			.06	.00
Affect × Young Adult			−.06	−.06
Self-Efficacy × Young Adult			.02	−.02
HPV Vaccine Confidence × Young Adult			−.05	−.03
Vaccine Confidence × Young Adult			−.15*	−.12†
HPV-Related Knowledge × Young Adult			.12*	.16*
Message Influence Features				
Human Agency				−.07
Virus Agency				−.16
Deviance				−.14
Norm				−.04
Interactions: Psychological Variables × Agency Assignments				
Severity × human Agency				.15*
Severity × Virus Agency				.19**
Affect × human Agency				.02
Affect × Virus Agency				−.15*
Self-Efficacy × human Agency				.04
Self-Efficacy × Virus Agency				.08
HPV Vaccine Confidence × human Agency				−.10
HPV Vaccine Confidence × Virus Agency				−.03
Vaccine Confidence × human Agency				−.04
Vaccine Confidence × Virus Agency				−.03
HPV-Related Knowledge × human Agency				−.01
HPV-Related Knowledge × Virus Agency				−.01
Interactions: Psychological Variables× DRM				
Severity × Deviance				.02
Severity × Norm				.07
Affect × Deviance				−.10
Affect × Norm				.16*
Self-Efficacy × Deviance				.08
Self-Efficacy × Norm				.02
HPV Vaccine Confidence × Deviance				−.04
HPV Vaccine Confidence × Norm				−.09
Vaccine Confidence × Deviance				.06
Vaccine Confidence × Norm				−.05
HPV-Related Knowledge × Deviance				.11†
HPV-Related Knowledge × Norm				−.10

All variables, except for target group and message influence features, were standardized. Sex was coded 1 for female and 0 for male. Health Insurance Plan Status was coded 1 for having a health insurance plan and 0 for having no health insurance plan. Target Group stands for young adults, referent to parents. DRM = Deviance Regulation Marking.

†$p < .1$; *$p < .05$; **$p < .01$; ***$p < .001$.

Message agency assignment had no significant moderating effects on other psychological variables with $p > .05$. The significant interaction effects between psychological variables and message agency assignments are shown in Figure 3.

The interaction analysis in Model 4 also addressed RQ3. Results indicated that the effect of people's affect about HPV contracting on vaccination intention for the group vaccination as the norm was $\beta = .42$, which was significantly higher

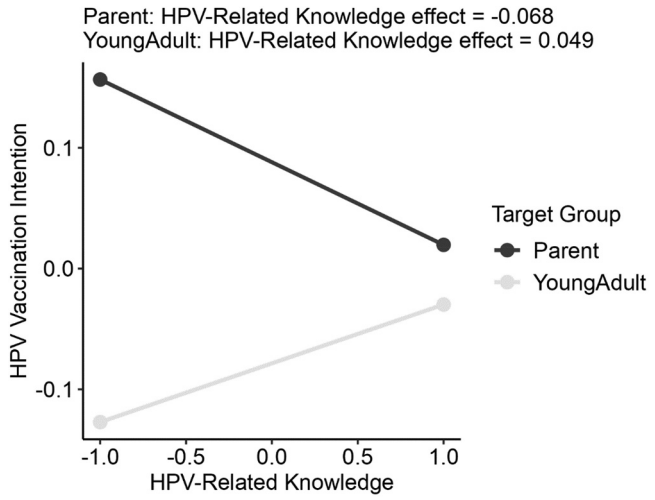

Figure 2. Interaction between HPV-related knowledge and target group predicting HPV vaccination intention. HPV-related knowledge and HPV vaccination intention were standardized. The standardized β was -.07 ($t = 2.0$, $p = .05$) for parents and .05 ($t = 6.9$, $p = .10$) for young adults. The difference in β of parents vs. young adults was significant ($t = 2.3$, $p = .02$).

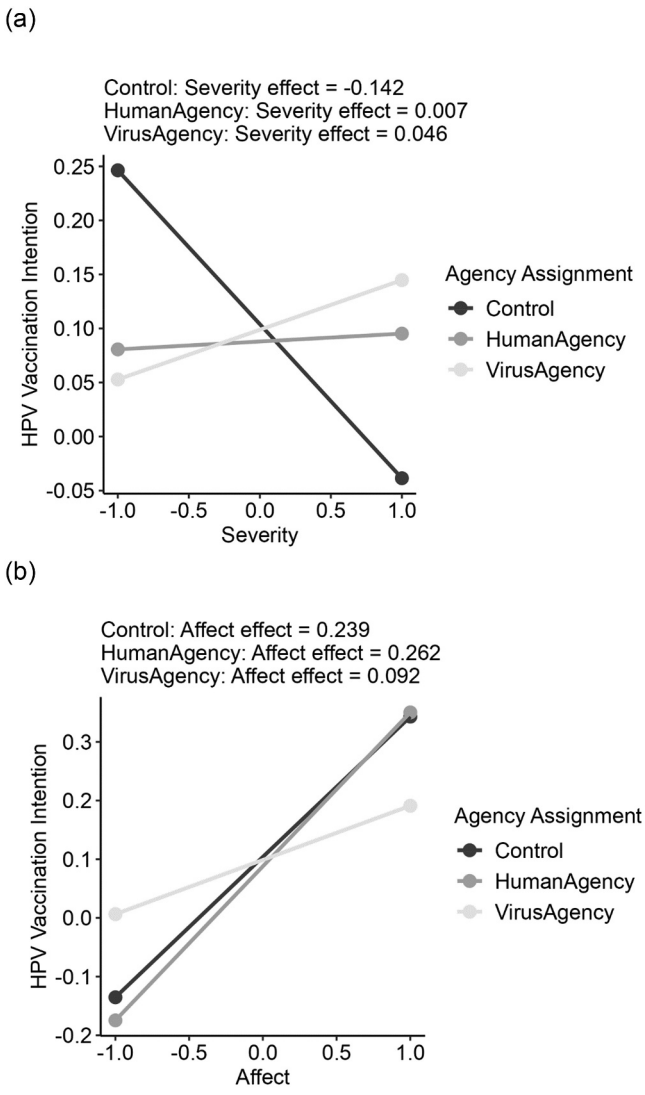

Figure 3. (a) Interaction between severity and agency assignment predicting HPV vaccination intention. (b) Interaction between affect and agency assignment as predicting HPV vaccination intention. Severity and HPV vaccination intention were standardized. The standardized β was -.14 ($t = 0.4$, $p = .68$) for no agency, .01 ($t = 1.0$, $p = .31$) for human agency, and .05 ($t = 1.6$, $p = .12$) for virus agency. The difference in β of control vs. human agency was significant ($t = 2.1$, $p = .04$). The difference in β of control vs. virus agency was significant ($t = 2.6$, $p = .009$). Although this interaction is mathematically significant, it has no implication on HPV Vaccination Intention, which is consistent with the main effect for severity. Affect and HPV vaccination intention were standardized. The standardized β was .24 ($t = 1.6$, $p = .10$) for no agency, .26 ($t = 4.7$, $p < .001$) for human agency, and .09 ($t = 2.9$, $p = .004$) for virus agency. The difference in β of control vs. virus agency was significant ($t = 2.1$, $p = .04$). The difference in β of human agency vs. virus agency was significant ($t = 2.4$, $p = .02$).

than the control group $\beta = .26$ ($t = 2.1$, $p = .04$). Further inspection indicated that for the group vaccination as the norm, the effect was significantly higher than the group of deviance $\beta = .16$ ($t = 3.6$, $p < .001$). Results indicated that the effect of HPV and vaccine knowledge on vaccination intention for the group vaccination as the norm was $\beta = -.18$, which was not significantly lower than the control group $\beta = -.09$ ($t = -1.6$, $p = .11$). Further inspection indicated that the effect of HPV and vaccine knowledge for the group of vaccination as the norm was significantly lower than the group of vaccination as the deviance $\beta = .02$ ($t = 3.7$, $p < .001$). Message deviance regulation markings had no significant moderating effects on other psychological variables, $p > .05$ in all cases. The significant interaction effects between psychological variables and message deviance regulation markings are shown in Figure 4.

To explore the relationship between young adults and parents and their psychological variables, we conducted a MANOVA (see Table 5). Results indicated between parents and young adults, there were significant differences in affect (parent: $M = 4.6$, $SD = 1.6$; young adult: $M = 4.2$, $SD = 1.6$; $F(1, 700) = 15.1$, $p = .001$), self-efficacy (parent: $M = 5.3$, $SD = 1.3$; young adult: $M = 4.7$, $SD = 1.4$; $F(1, 700) = 80.7$, $p < .0001$), HPV-related knowledge (parent: $M = 4.6$, $SD = 1.6$; young adult: $M = 3.6$, $SD = 1.6$; $F(1, 700) = 26.0$, $p < .0001$), and vaccination intention (parent: $M = 4.6$, $SD = 1.8$; young adult: $M = 4.2$, $SD = 1.6$; $F(1, 700) = 10.5$, $p = .001$). There was a significant difference in severity among different agency assignments ($F(2, 700) = 4.0$, $p = .02$). A post hoc test revealed that there was a significant difference between the virus agency assignment ($M = 5.4$, $SD = 1.6$) and the control assignment ($M = 5.0$, $SD = 1.4$; $p = .02$), but there was no significant difference between these two agency assignments and the human agency assignment ($M = 5.3$, $SD = 1.6$), with $p > .05$. Regarding the interactions, the results indicated that the two-way interaction variable Agency Assignment × Deviance Regulation Marking had a significant effect on self-efficacy ($F(4, 700) = 2.5$, $p = .02$), and the three-way interaction variable Target Group × Agency Assignment × Deviance Regulation Marking had a significant effect on HPV vaccine confidence ($F(4, 700) = 2.6$, $p = .04$). These significant interaction effects are shown in Figures 5 and 6. Specifically, for young adults, using a combination of human agency and a deviation message significantly influenced HPV vaccine confidence more than the control, but using a combination of virus agency and a norming message significantly decreased vaccine confidence. In addition, using human agency and a deviation in combination lowered the vaccine confidence of parents.

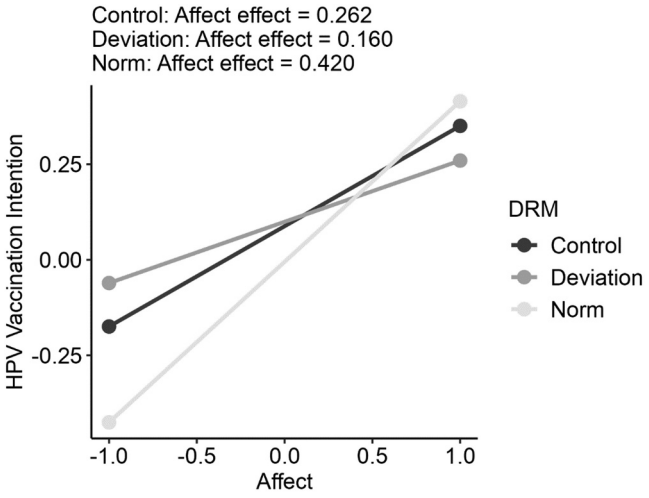

Figure 4. Interaction between affect and deviance regulation marking predicting HPV vaccination intention. DRM = Deviance Regulation Marking. Affect and HPV vaccination intention were standardized. The standardized β was .26 ($t = 1.9$, $p = .06$) for control, .16 ($t = 1.6$, $p = .11$) for deviation, and .42 ($t = 4.4$, $p < .001$) for norm. The difference in β of control vs. norm was significant ($t = 2.1$, $p = .04$).

Discussion

The reported study found evidence for psychometric factors that influence the HPV vaccination intentions of parents and young adults without children, as well as message factors that influence psychometric predictors of vaccination intention (finding summary see Table 6). Affective risk perception about contracting HPV, self-efficacy regarding securing vaccination, general confidence in vaccines and specific confidence in the HPV vaccine all were significant positive predictors of vaccination intention. Additionally, young adults' vaccination intentions for themselves were significantly lower than parents' vaccination intentions for their children, and the effects of vaccine confidence and HPV and vaccine knowledge differed between young adults and parents. However, being a young adult or a parent did not significantly interact with other psychological variables on vaccination intention. Furthermore, message influence features such as agency assignment and deviance regulation marking did not exert main effects on vaccination intention but did interact with psychometric factors to influence self-efficacy and vaccine confidence. Finally, differences were observed between parents and young adults in risk affect, self-efficacy, HPV and vaccine knowledge, and vaccination intention.

Research indicates that people are generally less loss averse when making decisions (health-related or otherwise) about others than themselves (Polman, 2012b). In the current study, we explored how self-other differences directly influence people's decision making (vaccination intention), but also investigated how self-other differences moderated emotional responses related to decisions. We discovered that parents had higher vaccination intentions than young people, which was consistent with previous research. In addition, our moderation analysis elucidated how people's emotional responses to risks were differently related to their decisions in different groups. The results revealed that the relationship between vaccine confidence and vaccination intention was higher in parents than in young adults. Interestingly, we found that young adults with more knowledge about HPV and HPV vaccines reported higher intentions to get vaccinated, while parents with more perceived knowledge reported lower intentions to have their children vaccinated. We speculate that this could be due to parents with children not vaccinated for HPV being exposed to more mis- and disinformation about HPV vaccines (Motta et al., 2018).

Furthermore, this study provided insights into how different message strategies influence decision making. We manipulated agency assignment and deviance regulation marking of the health text messages and discovered that these message features had no significant main effects on people's vaccination intentions and related psychological indicators. However, we found that the message strategies moderated people's emotional response, i.e., affect about contracting HPV, and in turn influenced people's HPV vaccination intentions. We found that virus agency weakened the positive effect of affect on HPV vaccination intentions while a norming message strengthened this effect. In addition, the results indicated that the two message strategies, agency assignment and deviance regulation marking, had complex interactions to influence people's psychological states. Analysis results revealed that when not mentioning deviance, virus agency increased self-efficacy, compared to human agency and no agency. Furthermore, message strategies exhibited interactions with the target group (parents vs. young adults) to influence target people's psychological states. We found that a message of human agency and not mentioning deviance increased parents' HPV vaccine confidence, while the same message decreased young adults' HPV vaccine confidence.

Practical implications

Our study offers several practical suggestions for healthcare professionals and governmental agencies to further improve HPV vaccination rates among teenagers and young adults. First, the significant main effect of target group on vaccination intention shows that targeting at parents of unvaccinated children is likely to yield better vaccination outcomes than targeting at young adults. This means that health authorities need to spend more efforts on reaching out to parents by creating various forms of educational materials such as adolescent vaccination schedules, public service announcements, vaccine information statements as well as disseminating them through various channels such as text message reminders, social media posts, and health consultations.

Second, the three-way interactions between target group and the two message influence factors also point to a more effective strategy to promote HPV vaccination among young adults. The optimal message combination identified in our study would be using human agency whilst framing abstention as the norm and praising the deviation. A sample message would read as "You could get HPV and increase your chances of developing several forms of cancer. You can reduce these changes by choosing to vaccinate. Vaccinating yourself gives you protection others around you do not have."

Table 5. MANOVA analysis of main and interaction effects of manipulated experimental variables on psychological variables.

Variables	*df*	SS	*F*	*p*
DV: Severity				
Target Group	1	0.6	0.2	.62
Agency Assignment	2	19.2	4.0	.02*
Deviance Regulation Marking (DRM)	2	3.3	0.7	.51
Target Group × Agency Assignment	2	12.8	2.7	.07†
Target Group × DRM	2	4.5	0.9	.40
Agency Assignment × DRM	4	11.2	1.2	.32
Target Group × Agency Assignment × DRM	4	4.3	0.4	.77
Residuals	700	1675.7		
DV: Affect				
Target Group	1	37.8	15.1	.001***
Agency Assignment	2	12.0	2.4	.09†
DRM	2	6.7	1.3	.27
Target Group × Agency Assignment	2	11.0	2.2	.11
Target Group × DRM	2	5.0	1.0	.37
Agency Assignment × DRM	4	11.5	1.1	.33
Target Group × Agency Assignment × DRM	4	2.2	0.2	.93
Residuals	700	1752.8		
DV: Self-Efficacy				
Target Group	1	47.8	26.0	<.0001****
Agency Assignment	2	3.3	0.9	.40
Deviance Regulation Marking	2	1.1	0.3	.74
Target Group × Agency Assignment	2	0.8	0.2	.80
Target Group × DRM	2	3.3	0.9	.41
Agency Assignment × DRM	4	18.4	2.5	.04*
Target Group × Agency Assignment × DRM	4	8.0	1.1	.36
Residuals	700	1286.1		
DV: HPV Vaccine Confidence				
Target Group	1	1.4	1.4	.24
Agency Assignment	2	1.6	0.8	.45
DRM	2	1.3	0.6	.53
Target Group × Agency Assignment	2	3.8	1.9	.16
Target Group × DRM	2	1.5	0.7	.48
Agency Assignment × DRM	4	5.4	1.3	.27
Target Group × Agency Assignment × DRM	4	10.6	2.6	.04*
Residuals	700	717.4		
DV: Vaccine Confidence				
Target Group	1	8.0	3.2	.07†
Agency Assignment	2	3.0	0.6	.55
DRM	2	2.2	0.4	.64
Target Group × Agency Assignment	2	2.2	0.5	.64
Target Group × DRM	2	2.3	0.5	.63
Agency Assignment × DRM	4	2.3	0.2	.92
Target Group × Agency Assignment × DRM	4	11.6	1.2	.32
Residuals	700	1737.7		
DV: HPV and Vaccine Knowledge				
Target Group	1	202.1	80.7	<.0001****
Agency Assignment	2	2.2	0.4	.64
DRM	2	0.3	0.1	.94
Target Group × Agency Assignment	2	9.0	1.8	.17
Target Group × DRM	2	6.3	1.2	.29
Agency Assignment × Deviance Regulation Marking	4	8.3	0.8	.51
Target Group × Agency Assignment × DRM	4	6.8	0.7	.61
Residuals	700	1753.5		
DV: Vaccination Intention				
Target Group	1	31.0	10.5	.001**
Agency Assignment	2	4.2	0.7	.49
DRM	2	4.5	0.8	.47
Target Group × Agency Assignment	2	9.1	1.5	.22
Target Group × DRM	2	5.5	0.9	.40
Agency Assignment × DRM	4	6.4	0.5	.71
Target Group × Agency Assignment × DRM	4	19.7	1.7	.16
Residuals	700	2071.3		

DRM = Deviance Regulation Marking. †$p < .1$; *$p < .05$; ***$p < .001$; ****$p < .0001$.

Limitations and future research

We used regression analysis to investigate the relationship between multiple psychological variables and vaccination intentions, not confirming the causality of the effects. Since other psychological factors, such as perceived benefits of vaccination, may affect people's vaccination intentions as well (Rosenstock, 1974), we do not have enough evidence to determine the causality that the changes in people's vaccination intentions were brought by our focal psychological variables. Moreover, according to the Cs framework, complacency, constraints, confidence, calculation, and collective responsiveness can affect vaccination intent and hesitancy (Betsch et al., 2018), while our study did

Table 6. Findings of hypotheses and research questions.

Hypothesis/Research Question	Finding
H1. The perceived severity of HPV, affect about contracting HPV, self-efficacy about HPV vaccination, confidence in the HPV vaccine and in vaccines in general, and HPV-related knowledge are positively related to vaccination intention.	Partially supported Affect, self-efficacy, HPV vaccine confidence, and vaccine confidence were positively related to HPV vaccination intention.
H2. Parents have higher posttest vaccination intentions for their children than young adults do for themselves.	Supported
RQ1. How do the psychological predictors of HPV vaccination intention vary between parents deciding to vaccinate their children and young adults vaccinating themselves?	Parents had higher affect, higher self-efficacy, and more HPV-related knowledge than young adults. Higher HPV-related knowledge predicted lower vaccination intention in parents, but the same trend was not found in young adults.
H3. HPV vaccination reminder text messages using virus agency message strategies increase people's vaccination intentions relative to other agency assignments (human agency and no agency).	Not supported
RQ2. How does agency assignment influence the relationship between vaccination intention and related psychological states?	Virus agency weakened the positive effect of affect on HPV vaccination intentions, compared to human agency and no agency.
H4. HPV vaccination reminder text messages that characterize vaccination as the norm increase people's vaccination intentions relative to other deviance regulation markings (vaccination as the deviance and not mentioning norms).	Not supported
RQ3. How does deviance regulation marking influence the relationship between vaccination intention and related psychological variables?	A norming message strengthened the positive effect of affect on HPV vaccination intentions, compared to not mentioning norms.

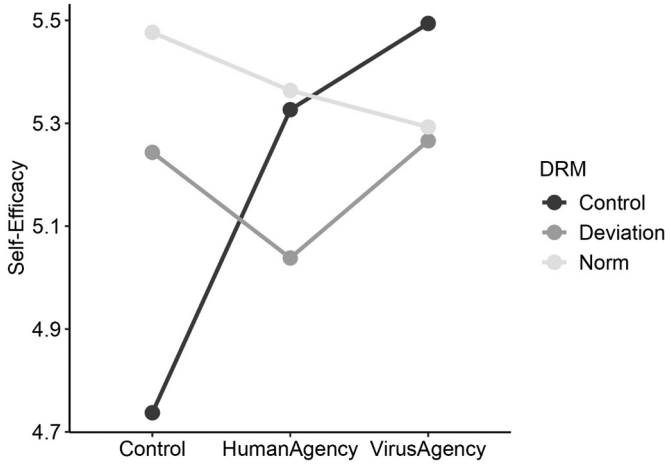

Figure 5. Interaction between agency assignment and deviance regulation marking predicting self-efficacy. DRM = Deviance Regulation Marking. When there was no agency assignment, a norming or deviation message significantly *increased* self-efficacy more than no DRM message ($p = .02$). When there was no DRM message, virus agency significantly *increased* self-efficacy more than no agency ($p = .005$) and human agency ($p = .04$).

not examine calculation and collective responsiveness. Thus, we suggest future research to explore different potential psychological mechanisms related to vaccination intentions. Future research can design fine-grained experiments to examine the effects of psychological states on vaccination intentions.

We measured vaccination intentions, rather than actual behaviors. While our study identified effective strategies to elevate people's intention to vaccinate against HPV, we did not directly measure their actual vaccination behaviors. In addition, since we recruited parents of children aged 17 or under, some parents might have children under 9 who were ineligible for HPV vaccines. Their vaccination intentions could have been disconnected from the behaviors. We are unsure whether the persuasive advantage identified in this study is enduring or ephemeral. Future studies can move beyond measures of behavioral intentions such as adding a link for participants to actually sign up for HPV vaccination and following up on their completion rates of different vaccine doses.

We selected parents and young adults as two target groups to test self-other differences. However, extant research indicated when making decisions, parental roles are different from other roles, such as friends, strangers, or health providers (Batteux et al., 2019). We could not confirm whether the differences between parents and young adults were generated by self-other differences or the unique natures of parental roles. If the characteristics of parental roles influence the results, it would be helpful for future studies to investigate different types of parents, include multiple target groups, and compare the findings in different groups.

Our study did not find significant main effects of the two message influence strategies on people's vaccination intentions. One possible explanation is that the message manipulations implemented in this study were rather short so they may not have created a strong enough impression on the readers. Future studies may consider using multiple manipulations for the same message strategy in a longer health educational message and presenting the message influence strategies in more engaging forms such as through an animated public service announcement video.

Testing the effects of agency assignment, deviance regulation marking, and target group across different languages and cultures is another suggestion for future research. Testing agency assignment across different languages is important because different types of languages have different ways of marking agency. English (nominative-accusative) is only one of the three major types, along with ergative-absolutive and stative-active languages (Duranti, 2004). In fact, Chinese does not fall into any of the three types.

Testing deviance regulation marking across cultures is also intriguing because people's reactions to norm deviance can differ across cultures (Jia, 2024). It is likely that deviance regulation may work stronger in some other countries. It is likely that the effect of DRM is moderated by regions in the U.S. because research has shown that the 50 states in the U.S. "differ in tightness (many strongly enforced rules and little tolerance for deviance) versus looseness (few strongly enforced rules and greater tolerance for deviance)" (Harrington & Gelfand, 2014).

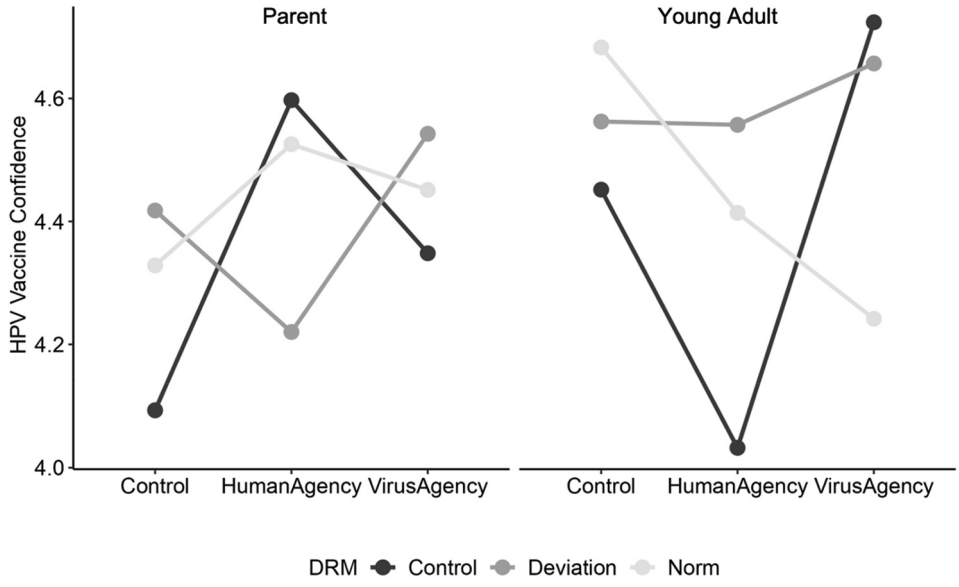

Figure 6. Interaction between target group, agency assignment, and DRM predicting HPV vaccine confidence. DRM = Deviance Regulation Marking. For parents, a message with human agency and a deviation message significantly *decreased* HPV vaccine confidence more than a norming message or the control ($p = .05$). When there was no DRM message, human agency *increased* HPV vaccine confidence than the control ($p = .02$). For young adults, a message with human agency and a deviation or norming message significantly *increased* HPV vaccine confidence more than the control ($p = .03$). When there was virus agency, a norming message significantly *decreased* HPV vaccine confidence more than a deviation message or the control ($p = .04$). When there was no DRM message, virus agency *increased* HPV vaccine confidence significantly more than human agency ($p = .001$).

Testing the difference of target groups on the outcome variables across cultures and regions could also be important. Most of the studies are conducted in the U.S. However, cultures differ considerably in terms of their tendency to make decisions for others (agentic vs. communal).

Conclusion

We found that affective risk perception, self-efficacy, general confidence in vaccines, and specific confidence in the HPV vaccine were positive psychometric factors that influenced HPV vaccination intention. We discovered parent vs. young adult decision-making differences in that young adults' vaccination intention for themselves were lower than parents' vaccination intentions for their children. Our experiment also showed that message features such as agency assignment and deviance regulation marking had no main effects on vaccination intention but had interactions with psychometric predictors.

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Appendix

Survey instruments

	Parent	Young adult
Severity (1 = Very strongly disagree; 7 = Very strongly agree)	1. HPV is dangerous. 2. HPV can have serious negative health consequences. 3. Getting HPV could harm my child's health in the future.	
Affect (1 = Very strongly disagree; 7 = Very strongly agree)	1. I am concerned about my child contracting HPV. 2. When I think about my child contracting HPV for a moment, I feel fearful. 3. When I think about my child contracting HPV for a moment, I feel anxious. 4. When I think about my child contracting HPV for a moment, I feel worried. 5. Considering any potential effects that HPV might have on my child, I am concerned about contracting HPV.	1. I am concerned about contracting HPV. 2. When I think about contracting HPV for a moment, I feel fearful. 3. When I think about contracting HPV for a moment, I feel anxious. 4. When I think about contracting HPV for a moment, I feel worried. 5. Considering any potential effects that HPV might have on me personally, I am concerned about contracting HPV.
Self-Efficacy (1 = Very strongly disagree; 7 = Very strongly agree)	1. I will be able to get both doses of the HPV vaccine for my child if I decide to do it. 2. There is nothing that would stop me from getting the HPV vaccine for my child if I want it. 3. It will be easy for me to get my child vaccinated against HPV if I decide to do so. 4. I know where to go to get my child vaccinated against HPV if I decide to do it.	1. I will be able to get both doses of the HPV vaccine, if I decide to do it. 2. There is nothing that would stop me from getting the HPV vaccine if I want it. 3. It will be easy for me to get vaccinated against HPV if I decide to do so. 4. I know where to go to get vaccinated against HPV if I decide to do it.
HPV Vaccine Confidence (1 = Very strongly disagree; 7 = Very strongly agree)	1. HPV vaccination is necessary to protect the health of children. 2. The HPV vaccine does a good job of preventing the diseases it is intended to prevent. 3. The HPV vaccine is safe. 4. If I do not get my child vaccinated against HPV, my child may contract dangerous diseases. 5. If I do not get my child vaccinated against HPV, my child may cause other people to contract dangerous diseases. 6. Teenagers don't need the HPV vaccine. (Reverse) 7. Vaccinating my child against HPV may cause serious side effects. (Reverse) 8. The medical professionals in charge of HPV vaccination have my child's best interest at heart.	1. HPV vaccination is necessary to protect my health. 2. The HPV vaccine does a good job of preventing the diseases it is intended to prevent. 3. The HPV vaccine is safe. 4. If I do not get vaccinated against HPV, I may contract dangerous diseases. 5. If I do not get vaccinated against HPV, I may cause other people to contract dangerous diseases. 6. Young adults don't need the HPV vaccine. (Reverse) 7. Getting vaccinated against HPV may cause serious side effects. (Reverse) 8. The medical professionals in charge of HPV vaccination have my best interest at heart.
General Confidence (1 = Very strongly disagree; 7 = Very strongly agree)	1. I am completely confident that vaccines are safe. 2. Vaccinations are effective. 3. Regarding vaccines, I am confident that public authorities decide in the best interest of the community.	
HPV-Related Knowledge (1 = Extremely unfamiliar; 7 = Very familiar)	1. How familiar are you with how HPV is transmitted from person to person? 2. How familiar are you with the kinds of health problems HPV can cause? 3. Before participating in this survey, how familiar were you with the cancers associated with HPV infection? 4. How familiar are you with the HPV vaccine?	
HPV Vaccination Intention (1 = Very strongly disagree; 7 = Very strongly agree)	1. If my healthcare provider recommends it, I will get the HPV vaccine for my child. 2. I intend to get my child vaccinated against HPV.	1. If my healthcare provider recommends it, I will get the HPV vaccine. I intend to get vaccinated against HPV.