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The influence of national origin cues in HPV vaccination advertising: An eye-tracking study of visual attention and vaccine perception using quantitative and qualitative analysis

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ABSTRACT

This study is among the first to investigate how national origin cues influence visual attention and perception in HPV vaccine advertisements, using eye-tracking technology to provide objective insights into consumer responses. By integrating methods from public health, psychology, and advertising research, this study explores how visual attention is shaped by national affiliation cues. In a controlled experimental setting with a sample of 40 UK university students, we investigated visual attention and effectiveness of HPV vaccination advertisements by comparing ads disclosing the national origin of the vaccine and without any origin information. We assessed total fixation duration and time to first fixation to various elements of the ad, along with intention and attitude measures. Contrary to one of our hypotheses, we did not find significant differences in intention ($p = .758$) and attitude ($p = .620$) measures. However, there was significant difference in total fixation duration toward one of the ad images between conditions ($p = .043$). The qualitative analysis reveals the role of country-of-origin (COO) in HPV vaccination advertising, suggesting a shift in attention from that image to the COO cue. Furthermore, eight out of the 20 participants in the treatment condition did not fixate at the COO cue. Findings provide critical insights for public health communication strategies, suggesting that the use (or omission) of national origin cues in vaccine advertisements could influence vaccine perception and hesitancy. These results highlight the need for strategic messaging approaches to enhance HPV vaccine acceptance and improve public trust in domestic and international vaccines.

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Introduction

The human papillomavirus (HPV) is a virus primarily transmitted through sexual activity and a significant cause of various cancers, most notably cervical cancer, where HPV infection accounts for over 99% of cases.[1–3] Additionally, recent studies indicate that HPV may accelerate disease progression in other cancers, such as breast and prostate cancers.[4]

Vaccination is the most effective method for preventing HPV infection. Currently available vaccines include bivalent, quadrivalent, and nonavalent formulations, which effectively protect against the most harmful types of HPV, such as types 16 and 18.[4–6] Initial results show that these vaccines are successfully reducing the incidence of cervical cancer[1,2,7] and recurrent respiratory papillomatosis (RRP).[8] Despite this, global vaccination coverage remains inadequate in many regions,[5,9,10] hindering efforts to achieve desired immunization levels.

The high hesitancy toward HPV vaccines primarily stems from its association as a sexually transmitted infection (STI).[6] Parents often hesitate to vaccinate their children due to beliefs that they are not sexually active or fears that the vaccine may encourage premature sexual activity.[11–14] Young adults also exhibit hesitancy, mostly due to concerns about vaccine safety and religious beliefs.[8,15,16] Additionally, suspicions regarding health interventions imposed by Western governments in African countries,[17] combined with a lack of trust in regulatory bodies and concerns about transparency in clinical trials, can increase hesitancy.[18] The COVID-19 pandemic has also contributed to a decline in HPV vaccination rates in some countries in recent years,[19–21] possibly due to the strengthening of conspiracy theories during the pandemic.[22–24]

During the COVID-19 pandemic, a notable phenomenon emerged where individuals expressed preferences based on the country of origin of vaccines. Many expressed a willingness to accept vaccines only from certain countries, indicating a country-of-origin (COO) effect on vaccination. The COO effect refers to a marketing phenomenon where the origin country of a product affects decisions, purchase intention, trust, and perceptions of brand value and image.[25–30]

Traditional studies on the COO effect established a preference for domestic products, especially in developed countries.[31–33] Recent research on the COO effect in the context of COVID-19 vaccination has similarly revealed a national bias among individuals in various countries. This preference was observed in numerous countries, such as the USA,[34,35] the UK,[36] Hungary,[37] Japan[38] and Ghana.[39] Furthermore,

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a multicultural study confirmed the national bias in 11 out of 14 countries surveyed.[40]

The COO effect has been widely studied in consumer health choices, including pharmaceutical preferences and vaccine adoption.[41,42] Research on influenza and polio vaccines suggests that individuals often perceive domestically produced vaccines as safer or more effective than imported alternatives, particularly in regions with strong national health identity.[43,44] Similarly, HPV vaccine hesitancy has been linked to concerns over manufacturing origins, especially in countries with pre-existing distrust toward foreign medical products.[45] However, while COO preferences have been extensively examined in prescription drugs and COVID-19 vaccines, limited research has explored their influence on HPV vaccine acceptance, particularly in the context of vaccine advertising.

At present, the majority of countries utilize the Gardasil HPV vaccine, developed by the American pharmaceutical company Merck Sharp and Dohme (MSD). However, alternative vaccines are also available, including Cervarix, developed by the British company GlaxoSmithKline, and Cecolin, developed by the Chinese company Xiamen Innovax.[46] Additionally, SinoCelltech, a Chinese company, is conducting phase III trials for a 14-valent HPV vaccine, which, if successful, may offer greater efficacy compared to the currently available options.[47] With the end of the COVID-19 pandemic, the observed preference for national vaccines may extend to other vaccines, such as the HPV vaccine.[48] Should this scenario materialize, it would be important to examine the influence of national origin cues in vaccine communication.

These national origin cues can take various forms, such as "made in," "manufactured in," or "assembled in."[31] If a preference for national HPV vaccines is confirmed, health professionals could leverage this preference in their communication strategies, while local companies could be incentivized to develop domestic HPV vaccines. Additionally, the local manufacturing of foreign vaccines could lead to reduced costs, technology transfer, decreased foreign dependence, workforce development, and job creation.[39,49,50] However, to the best of our knowledge, no studies have specifically investigated the COO effect for other vaccines, although some have explored it in hypothetical pandemic scenarios.[51,52] Hence, we propose a preliminary investigation into the impact of communicating the national origin of an HPV vaccine through a COO cue.

Unlike COVID-19 vaccines, which were developed and distributed in an environment of heightened geopolitical tensions and rapid innovation, HPV vaccines have been widely available for over a decade and are not linked to immediate public health crises.[1,2,11] As a result, COO perceptions in HPV vaccination may operate differently, influencing trust and acceptance based on long-standing public attitudes toward vaccine manufacturers rather than urgent risk perception.[51] Understanding these distinctions is critical for designing effective public health campaigns that leverage or counteract COO cues in HPV vaccine promotion.[53,54]

HPV vaccination messages, particularly advertisements, are powerful tools to inform and motivate individuals to vaccinate.[55,56] Hence, investigating the impact of a national country-of-origin (COO) cue in HPV vaccination ads, compared to ads without such disclosure, offers a valuable opportunity to deepen our understanding.

In health communication, including vaccination campaigns, it is vital to understand where individuals focus their attention, given that humans are predominantly visual beings and rely heavily on vision to process information.[57–63] Due to the brain's limited capacity to process all available information, humans use selective visual attention to filter and prioritize what is most relevant.[64–66]

Eye-tracking studies have provided valuable insights into how vaccine advertisements shape public perception and behavioral intention.[55,59,67,68] Previous research on HPV vaccine hesitancy and advertising suggests that visual attention is a key predictor of message effectiveness, with fixation count correlating with perceptions of message credibility.[69] In the context of HPV vaccine campaigns, studies have found that message framing, color schemes, and imagery impact viewer engagement,[55,69–78] but limited work has examined the role of COO cues in influencing visual attention.[79] This study builds upon these findings by applying eye-tracking methodology to examine how COO cues affect the way individuals process HPV vaccine advertisements, providing new insights into the intersection of national branding and health communication.

In the field of advertising, the role of bottom-up selective attention is well-established.[80–83] The stimulus-driven theory of visual attention posits that our visual attention is influenced by bottom-up mechanisms, which bias attention toward the most salient elements in a scene.[84–86] Specifically, features that differ from their surrounding distractors are more likely to capture attention.[87] However, it is important to note that the neural mechanisms underlying bottom-up selective attention remain complex and not fully defined.[88]

In HPV vaccination advertisements, a country-of-origin (COO) cue, such as the display of a nation's flag and name, serves as a salient visual element. According to the stimulus-driven theory, this cue is likely to capture attention due to the bottom-up mechanisms of selective visual attention.[57,86,89] Consequently, the inclusion of the COO cue is likely to draw attention away from other advertisement features, potentially altering visual attention patterns (e.g., fixation duration and time to first fixation) between ads that disclose national origin and those that do not. Therefore, we hypothesize:

H1: In HPV vaccination advertisements, the disclosure of national origin through a COO cue modifies visual attention toward other advertisement features.

The application of cue utilization theory in the context of product origin suggests that the COO cue functions as an extrinsic factor that shapes consumer perceptions of product quality. Specifically, consumers often rely on their evaluation of a product's country of origin to infer its quality.[27,79,90] In the case of vaccines, where information regarding the vaccine's brand is frequently absent and brand awareness is generally low, the country-of-origin may serve as a crucial cue for consumers in assessing the vaccine's quality.[91,92]

Building upon cue utilization theory and the observed COO effect in the context of COVID-19 vaccines,[33–39] it is plausible

to hypothesize that disclosing the national origin of HPV vaccines in advertisements may enhance motivation to vaccinate, potentially yielding more favorable outcomes compared to situations where the origin is not explicitly revealed. Accordingly, we propose the following hypothesis:

H2: In HPV vaccination advertisements, disclosing the national origin through a COO cue enhances intentions and attitudes. Specifically:

H2a: In HPV vaccination advertisements, disclosing the vaccine's national origin results in higher vaccination intention compared to not disclosing the origin;

H2b: In HPV vaccination advertisements, disclosing the vaccine's national origin results in more favorable HPV vaccination attitude compared to not disclosing the origin;

H2c: In HPV vaccination advertisements, disclosing the vaccine's national origin results in more favorable ad attitude compared to not disclosing the origin;

In this study, conducted within a controlled laboratory setting, we examined the visual attention patterns and effectiveness of HPV vaccination advertisements by comparing ads that disclose the national origin of the vaccine with those that do not provide origin information. This investigation aims to provide pioneering insights into the impact of a national COO cue on HPV vaccination messages.

Materials and methods

This study investigates the impact of a national country-of-origin cue on HPV vaccination advertisements using a between-subjects experimental design. Participants were divided into two groups: a treatment group, where the national origin was disclosed through a COO cue, and a control group, where no origin information was provided. The research was conducted in a laboratory setting in a culturally diverse city in the UK. The independent variable was the presence of origin information (disclosed/not disclosed). Dependent variables encompassed total fixation duration and time to first fixation to textual content and images, HPV vaccination intention, HPV vaccination attitude, and ad attitude. Eye movements were tracked using the Tobii Pro Spark eye-tracker model (ET) in conjunction with Tobii Pro Lab software throughout the experiment. Ethical approval for the study was obtained from the university's ethics committee.

Participants

Given that the study was conducted in the UK, where the HPV vaccine is freely available only to individuals aged 12–25, we specifically recruited adults within the 18–25 age range. The study recruited 41 university students in the UK, a sample that may not fully represent the broader population's vaccine perceptions. Most of them were students at the Dyson School of Design Engineering, Imperial College London. We asked participants whether they were healthcare workers, and none reported being in the healthcare field. University students tend to have higher education levels and greater exposure to public health campaigns, which could influence their familiarity with HPV vaccination. Additionally, age, gender balance, and prior HPV vaccination status were not controlled, which may affect generalizability. Future research should include a more diverse sample, incorporating different age groups, education levels, and cultural backgrounds to better assess how COO cues influence vaccine attitudes across populations.

Participants took part in the experiment between December 2023 and January 2024. Recruitment targeted individuals on a British university campus and through advertisements displayed in campus surroundings. Data from one participant residing outside the UK was excluded to mitigate potential biases, yielding a final sample of 40 adults residing in the UK. Among them, 17 participants were UK-born, while the remaining participants were born in 11 other countries.

While our sample size may appear modest, it is consistent with typical sample sizes observed in eye-tracking studies within the field of health communication.[54,66,93,94] Moreover, a priori power analysis was conducted using G*Power 3.1 to determine the minimum sample size required to detect statistically significant differences in fixation duration and vaccine perception scores. Given the probability of using Mann-Whitney U non-parametric tests, we calculated the sample size considering a medium effect size ($r = 0.3$, Cohen's $d = 0.63$), a significance level of $\alpha = 0.05$, and a power of 0.80. A minimum of 68 participants was recommended. The current sample size ($n = 40$) approaches this threshold but may have limited power to detect small effect sizes. Future studies should consider increasing the sample size to improve statistical reliability.

Of the 40 participants in the study, 21 identified as female, 18 as male, and one chose not to disclose their gender. None reported being healthcare workers. 17 participants indicated they had received the HPV vaccine, 10 reported not having received it, and 13 were uncertain. Only two participants reported a history of HPV infection. Participants were randomly assigned to either the treatment or control condition, resulting in 20 participants allocated to each condition. No specific criteria or grouping methods were employed.

Stimuli

We developed advertisements in accordance with current guidelines for HPV vaccination among young adults in the UK. However, we did not design them based on any specific advertising theory. Instead, we adapted their content from HPV vaccination advertisements used in other countries, ensuring that participants had no prior exposure to them. The advertisements used in both the control and treatment conditions were largely identical, differing only by the inclusion of a national country-of-origin cue in the treatment condition. As depicted in Figures 1 and 2, the advertisements included textual content, two image components (depicting a healthcare worker with a vaccine and a heart logo), and a country-of-origin feature specific to the treatment condition.

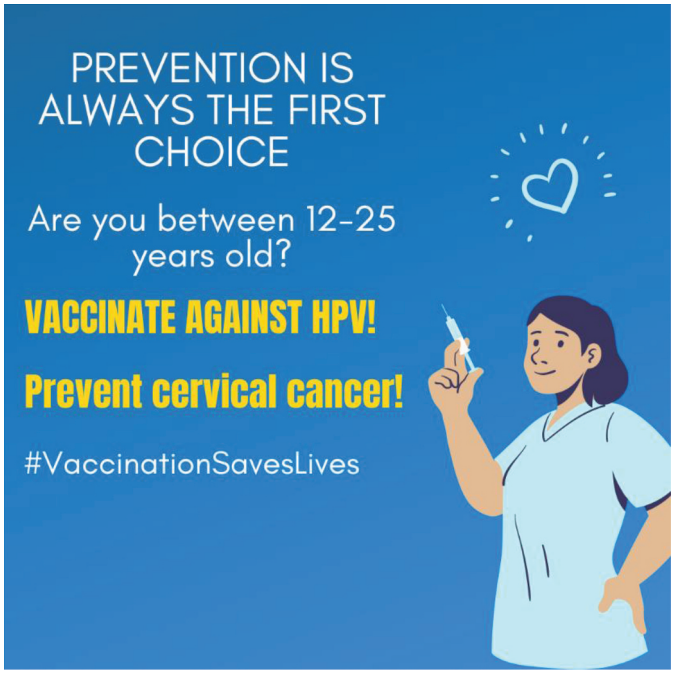

Figure 1. Advertisement in the control condition (national origin not disclosed). The advertisement includes textual content and two image components: a healthcare worker holding a vaccine and a heart logo.

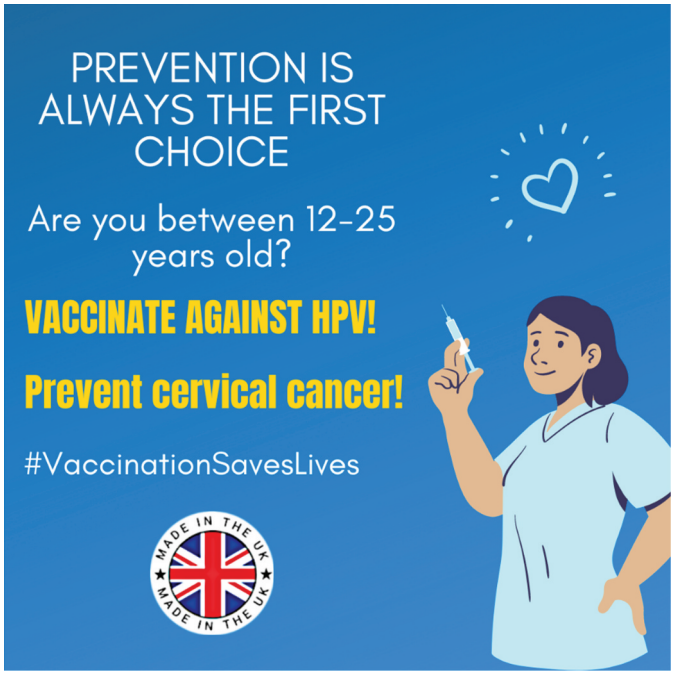

Figure 2. Advertisement in the treatment condition (national origin disclosed). The advertisement includes textual content, two image components – a healthcare worker holding a vaccine and a heart logo – and a country-of-origin cue.

Procedure

Upon arrival at the laboratory, participants were seated in front of a screen equipped with the ET. They were briefed on the study and provided with a Participant Information Sheet and Consent Form. Once consent was obtained, the session commenced. Given the sensitive nature of vaccination discussions, participants first viewed a neutral video sourced from Schaefer et al.'s[95] emotional video database to mitigate any potential emotional priming effects prior to the experiment.

Before eye-tracking commenced, the ET was calibrated for each participant using the calibration procedure within Tobii Pro Lab software. Subsequently, participants were exposed to an HPV vaccination advertisement for eight seconds. The exposure time of eight seconds per advertisement was selected based on prior eye-tracking studies,[54,96,97] which suggest that viewers typically process information before 15 seconds of exposure. Additionally, fixation duration was prioritized over saccades, as fixation time reflects cognitive engagement with vaccine messages, whereas saccadic movements are less directly linked to attention retention in static advertisements.[98–102] Future research may explore additional gaze measures, such as pupil dilation or scanpath analysis, to further examine cognitive processing during vaccine ad exposure.

Following the eye-tracking session, participants completed a questionnaire on the computer via Qualtrics. At the end of the experiment, participants watched the neutral emotional video again to ensure their emotional states were neutralized post-experiment. Finally, participants were thanked for their participation and provided with snacks as compensation.

Measures

In eye-tracking research, specific eye-movement events, particularly fixations and saccades, are of paramount importance. A fixation refers to a brief period during which the eyes remain relatively still and focus on a particular point in the visual field. During this phase, visual information is processed, enabling the extraction of meaning from the observed stimuli. A saccade is a rapid, ballistic movement that occurs between fixations, facilitating the shift of the line of sight from one point to another. Saccades are critical for enabling efficient scanning and the gathering of information from different regions of the visual field. While fixations typically last between 200 and 300 milliseconds, saccades are among the fastest movements performed by the human body, reaching velocities of up to 500 degrees per second.[99,102]

Tobii Pro Lab software provides two key measures relevant to our study: time to first fixation and total fixation duration. Total fixation duration refers to the cumulative duration of all fixations within a specific area of interest (AOI) during the entire exposure to the stimuli (e.g., eight seconds). In contrast, time to first fixation refers to the time elapsed before the participant's first fixation within a given AOI.

We measured time to first fixation and total fixation duration to all advertisement features by defining individual AOIs using Tobii Pro Lab software after recording eye movements with the ET. This allowed us to obtain measures of the time to first fixation to the text (TFF_{text}), the healthcare worker image (TFF_{image}), the heart logo (TFF_{heart}), and the COO cue (TFF_{COO}), as well as total fixation duration to the ($Fixation_{text}$), the healthcare worker image ($Fixation_{image}$), the heart logo ($Fixation_{heart}$), and the COO cue ($Fixation_{COO}$).

HPV vaccination intention was measured using four items on a 9-point Likert scale ranging from 'strongly disagree' to 'strongly agree,' based on Avery and Park.[54] However, we removed two items due to poor internal consistency (Cronbach's alpha = .639), remaining with two items (I plan to get vaccinated against HPV; I will get vaccinated against HPV), which demonstrated high reliability (Cronbach's alpha = .944, r = .895).

HPV vaccination attitude was measured using a five-item, seven-point semantic differential scale (1 = 'bad' to 7 = 'good;' 1 = 'Undesirable' to 7 = 'desirable;' 1 = 'unsafe' to 7 = 'safe;' 1 = 'unimportant' to 7 = 'important;' 1 = 'ineffective' to 7 = 'effective;' Cronbach's alpha = .850) based on Dunlop et al.[70]

Ad attitude was measured using a four-item, seven-point semantic differential scale (1 = 'unfavorable' to 7 = 'favorable;' 1 = 'bad' to 7 = 'good;' 1 = 'dislike' to 7 = 'like;' 1 = 'unpleasant' to 7 = 'pleasant;' Cronbach's alpha = .914) adapted from a recent eye-tracking and advertisement study.[103]

We also collected participants' socio-demographic information and potential control variables, including awareness of HPV, awareness of HPV vaccination, perception of HPV risk, familiarity with cervical cancer, history of HPV vaccination, history of HPV infection, and attitude toward vaccination (rated from 1 = "strongly against" to 5 = "strongly support"). Furthermore, participants were asked to identify the country they believed the vaccine in the advertisement originated from (Brazil/China/the United Kingdom/Not sure).

Results

Descriptive statistics

Across both treatment and control conditions, participants predominantly fixated on the text during the exposure period, with 66% of the time spent on it. In both conditions, three participants did not fixate on the healthcare worker image, while 12 participants in the treatment condition and 7 participants in the control condition did not fixate on the heart logo. However, all participants fixated on the text, with the first fixation occurring, on average, 0.18 seconds after exposure in the control condition and 0.27 seconds in the treatment condition. In the treatment condition, 8 out of 20 participants did not fixate on the COO cue. Among the 12 participants who fixated on the COO cue, the first fixation occurred after a mean time of 5.41 seconds, with the earliest fixation occurring at 2.28 seconds and the latest at 7.26 seconds after the start of the advertisement. Descriptive data for the visual attention measures are presented in Table 1.

Descriptive data for the intention and attitude measures are presented in Table 2. HPV vaccination intention and attitude were rated highly in both conditions, reflecting strong participant support for vaccination. Notably, even within the control group, the majority of participants believed the vaccine originated from the UK (11 participants), while only 5 were uncertain. In the treatment condition, 17 participants (85%) correctly identified the vaccine as originating from the UK. The subsequent subsection details the statistical tests conducted to assess significant differences between dependent variables in the treatment and control groups using IBM SPSS version 25.

Comparison between treatment and control conditions

First, we assessed whether we can assume that the dependent variables follow a normal distribution. As shown in Table 3, Shapiro-Wilk tests for normality indicated that we could accept the null hypothesis of normality in both conditions only for ad attitude (p = .481 in the control group and p = .276 in the treatment group) and $Fixation_{text}$ (p = .476 in the control group and p = .620 in the treatment group).

Table 1. Descriptive statistics for visual attention measures.

		$Fixation_{text}$ (s)	$Fixation_{image}$(s)	$Fixation_{heart}$ (s)	$Fixation_{COO}$ (s)	TFF_{text} (s)
Control	Mean	5.33	.61	.32	NA	.18
	SD	.93	.53	.40	NA	.20
	Max.	6.75	1.76	1.46	NA	.71
	Min.	3.81	0	0	NA	0
Treatment	Mean	5.22	.33	.09	.3670	.27
	SD	.79	.35	.12	.48	.40
	Max.	6.32	1.23	.32	1.58	1.76
	Min.	3.46	0	0	0	0
Total	Mean	5.28	.46	.21	NA	.23
	SD	.85	.46	.32	NA	.32

Note: NA stands for 'not applicable.'

Table 2. Descriptive statistics for intention and attitude measures.

		HPV vaccination intention	HPV vaccination attitude	Ad attitude
Control	Mean	6.13	6.09	5.26
	SD	2.03	0.91	1.10
	Max.	9	7	7
	Min.	3	4	3
Treatment	Mean	5.63	5.98	4.70
	SD	2.77	.83	1.06
	Max.	9	7	6.25
	Min.	1	4	2.25
Total	Mean	5.88	6.04	4.98
	SD	2.41	0.87	1.10

Table 3. Shapiro-wilk normality tests.

		W	df	*p*
HPV vaccination intention	Control	.902	17	.074
	Treatment	.872	17	.024*
HPV vaccination attitude	Control	.816	17	.003*
	Treatment	.906	17	.086
Ad attitude	Control	.952	17	.481
	Treatment	.936	17	.276
$Fixation_{heart}$	Control	.842	17	.008*
	Treatment	.738	17	.000*
$Fixation_{image}$	Control	.934	17	.257
	Treatment	.784	17	.001*
$Fixation_{text}$	Control	.951	17	.476
	Treatment	.959	17	.620
TFF_{image}	Control	.705	17	.000*
	Treatment	.814	17	.003*
TFF_{text}	Control	.863	17	.017*
	Treatment	.637	17	.000*

*Significant at .05 level.

Table 4. Mann-Whitney U non-parametric tests.

	HPV vaccination intention	HPV vaccination attitude	*Fixation heart*	*Fixation image*	*TFF image*	*TFF text*
Mann-Whitney *U*	188.500	181.500	125.000	137.500	92.500	179.000
Z	−.314	−.503	−2.147	−1.694	−1.792	−.573
Exact *p*	.758	.620	.043*	.081	.073	.583

*Significant at .05 level.

Hence, we employed a multivariate analysis of variance (MANOVA) to examine differences in ad attitude and $Fixation_{text}$ across conditions. For the remaining variables, we conducted Mann-Whitney U non-parametric tests.

The MANOVA test showed no statistically significant multivariate difference between conditions (Wilks' Lambda = .933, $F = 1.368$, $p = .276$, $\eta_p^2 = .067$), indicating that there were no statistic significant differences for ad attitude and $Fixation_{text}$ across conditions. As shown in Table 4, Mann-Whitney U non-parametric tests revealed a statistically significant difference across conditions only for $Fixation_{heart}$ ($U = 125.00$, $p = .043$, Cohen's $d = .78$). Therefore, $Fixation_{heart}$ was the only variable that exhibited a statistically significant difference between the treatment and control conditions. Consequently, H1 was partially supported as total fixation duration to one of the advertisement features (i.e., the heart logo) significantly differed between the treatment and control conditions. However, H2 was not supported, suggesting that disclosing the national origin through a COO cue may not enhance intentions and attitudes as hypothesized.

Given the small sample size of 20 participants per group, we opted not to apply multiple comparison corrections to preserve statistical power. While this approach increases the risk of Type I errors (false positives), the limited sample size and reduced power led us to prioritize minimizing Type II errors (false negatives), which could result in overlooking potential effects. It is also worth noting that the observed effect size for $Fixation_{heart}$ (Cohen's $d = .78$) at a significance level of $\alpha = 0.05$ resulted in a power ($1 - \beta$) of 0.76, which is close to the conventional value of 0.80.

By analyzing the heat maps depicting total fixation duration in the control (Figure 3) and treatment conditions (Figure 4), alongside the statistically significant difference observed for $Fixation_{heart}$ between conditions, we infer that in the treatment condition, visual attention was partially redirected from the heart logo toward the COO cue. In Figure 3, we observe longer fixations (i.e., warmer colors) on the healthcare worker's face, the syringe and the heart logo compared to Figure 4.

Figure 3. Heat map of total fixation duration in the control condition (warmer colors indicate longer fixations). High fixation intensity is observed on the healthcare worker's face, the vaccine, the number 12, and the heart logo.

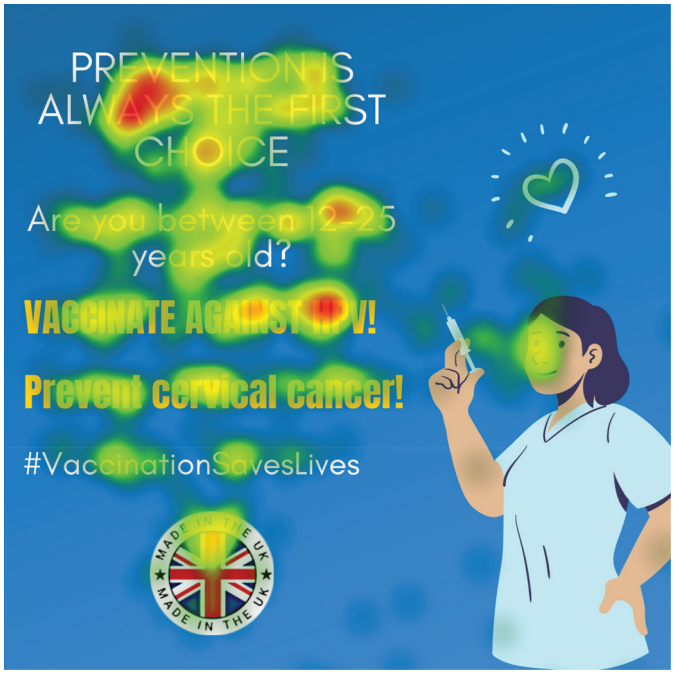

Figure 4. Heat map of total fixation duration in the treatment condition (warmer colors indicate longer fixations). High fixation intensity is observed at the end of the word "always" and on the word "HPV," with minimal fixation on the heart logo.

Discussion

In this study, we conducted an initial investigation into the impact of disclosing the national origin through a COO cue in HPV vaccination advertisements. Our analysis focused on measures of visual attention and effectiveness, comparing exposure to ads that disclosed the national origin (treatment condition) versus those without origin information (control condition). Our sample comprised students who exhibited strong support for vaccination, consistent with the high levels of HPV vaccination intention and positive attitudes reported in the UK.[104] Notably, 17 participants had already received the HPV vaccine, indicating minimal hesitancy toward HPV vaccination within our sample. Statistical analysis, including MANOVA and Mann-Whitney U tests, revealed that only total fixation duration to the heart logo differed significantly between conditions. Total fixation duration and time to first fixation to the text and healthcare worker image, as well as HPV vaccination intention, HPV vaccination attitude, and ad attitude, remained consistent across conditions. Consequently, our initial hypothesis (i.e., H2) regarding the impact of disclosing national origin through a COO cue on effectiveness was not supported.

The non-significant findings regarding intention and attitude measures were unexpected. Given the preference for national COVID-19 vaccines, it was anticipated that individuals exposed to advertisements featuring national origin information would demonstrate enhanced intentions and attitudes compared to those exposed to advertisements lacking such information. This expectation aligns with earlier research indicating a preference for national products.[30–32] Nevertheless, a significant proportion of participants in the control condition believed the vaccine to be of domestic origin. This suggests that the absence of origin information does not necessarily lead individuals to infer that the vaccine is foreign, thus maintaining their intentions and attitudes toward it similar to a domestic vaccine. Nevertheless, we cannot dismiss the possibility that the COO effect on vaccination may diminish with the conclusion of the COVID-19 pandemic.[51,105]

The reduced impact of COO cues in HPV vaccine advertising compared to previous findings in COVID-19 vaccine research suggests that external factors, such as vaccine familiarity and perceived risk, play a crucial role in shaping public attitudes. Unlike COVID-19 vaccines, which were developed under intense public scrutiny and global competition,[106] HPV vaccines have been widely available for over a decade and are part of established vaccination schedules. As a result, individuals may perceive less personal risk in HPV vaccination, leading to lower susceptibility to COO-driven hesitancy. This aligns with prior research indicating that COO cues are more impactful in decision-making for newly introduced or emergency-use vaccines.[105] Future studies should explore whether COO effects vary depending on a vaccine's stage in the public health lifecycle – whether it is a newly introduced vaccine, a widely used immunization, or one undergoing reputational shifts.

The significant finding regarding total fixation duration toward the heart logo, coupled with insights from the heat maps, provided valuable observations, partially supporting our first hypothesis. In the treatment condition, there was a discernible shift in visual attention from the heart logo to the COO cue. Thus, while the disclosure of national origin did not influence effectiveness, it also did not hinder the cognitive processing of textual information through visual attention,[107] a critical aspect in health communication. These findings suggest that disclosing national origin does not alter attention toward essential information. Further investigation is necessary to determine whether this observation is specific to the type of vaccine or if concerns about vaccine origin were primarily heightened during the COVID-19 pandemic.

Surprisingly, eight out of the 20 participants in the treatment condition did not fixate at the COO cue, which contrasts with the reasonable expectation that individuals would utilize the COO cue to evaluate the vaccine and shape their intentions and attitudes.[108] However, the proportion of participants fixating at the COO cue aligns closely with findings from recent studies that have examined visual attention toward COO cues.[79]

We expected that the salience of the COO cue in the advertisement would attract selective visual attention through a bottom-up mechanism. Instead, the controlled laboratory setting may have also activated a top-down mechanism, where participants viewed the task of observing the ad as a goal-oriented activity.[57,86,89] It aligns with current discussions in visual attention research, which suggests that while salient stimuli can automatically capture attention, this effect can be modulated by cognitive factors, task relevance and selection history.[109,110] However, more research is necessary to understand the underlying relations between visual attention to the COO cue and the COO effect.[79]

The variability in visual attention toward COO cues suggests that individual differences in cognitive processing, ad complexity, and prior vaccine beliefs may influence attention allocation. Some participants may have experienced cognitive overload, where competing visual elements (e.g., imagery, slogans, branding) diverted focus from the COO cue. Additionally, preexisting attitudes toward HPV vaccines or national healthcare systems may have affected subconscious information filtering, leading some participants to deprioritize COO cues. This aligns with research on motivated attention bias, where individuals focus more on health cues they perceive as personally relevant.[111–113] Future studies should explore whether prior vaccine awareness or health trust influences visual attention in vaccine ads using pre- and post-exposure surveys.

The observed attention patterns align with prior eye-tracking studies examining vaccine hesitancy and advertising.[54,58,66,67] Studies on COVID-19 vaccine promotion have found that visual attention is drawn more toward fear-based imagery than branding cues, which may explain why some participants overlooked the COO cue.[114] Similarly, research on HPV vaccine campaigns has shown that trust in public health institutions modulates ad engagement, suggesting that the effectiveness of COO cues may depend on preexisting national vaccine trust.[17,18,115] While the current study provides novel insights into COO effects, future research should compare domestic vs. foreign vaccine perceptions across different cultural contexts to determine how national identity influences visual engagement with health messaging. Furthermore, we acknowledge that the absence of theory-informed design may have influenced the visual salience and positioning of the COO cue, potentially contributing to the lower fixation rate observed.

While our experimental design provided an appropriate timeframe for assessing attention effects, it is limited in its ability to capture long-term impacts, which are essential for understanding sustained behavioral changes. Attention may influence immediate responses to health messages, but its effect on lasting attitudes and subsequent actions, such as vaccine uptake, requires further investigation. As such, we cannot assert that attention necessarily translates into tangible benefits for public health, particularly in terms of sustained behavior change.

Overall, while the effectiveness of national origin cues was limited in this context, our findings highlight their potential role in shaping vaccine perceptions and underscore the need for evidence-based communication strategies that support HPV vaccine uptake and foster trust in both domestic and internationally produced vaccines.

Practical implications

In this study, we present a preliminary investigation into the impact of communicating the national origin of an HPV vaccine through a COO cue. Although we did not observe improved outcomes with the presence of a COO cue, it did not hinder advertising effectiveness, despite some visual attention being directed toward the cue. Given that some countries use domestically developed or manufactured HPV vaccines (e.g., the USA), our results may encourage further exploration of the national origin of vaccines in communication efforts, as no negative outcomes were observed. Future studies could be particularly valuable on social media platforms (e.g., Instagram), where vaccine-related messaging can rapidly influence public perception.[116] The same reasoning applies if other companies, such as GlaxoSmithKline, successfully develop a new HPV vaccine for national use in the UK.

These findings have important implications for government vaccine messaging strategies. While COO cues may not significantly shift immediate vaccination intentions, they could influence public trust in national vaccine production over time. Policymakers should consider integrating COO cues strategically, ensuring they do not distract from core health messaging but instead reinforce trust in national vaccine programs. Additionally, targeted vaccine campaigns could be tailored based on demographic factors (e.g., age, nationality, vaccine hesitancy level) to optimize message effectiveness. Future public health efforts should incorporate a combination of eye-tracking and post-exposure behavioral assessments to better understand how visual engagement translates into real-world vaccine uptake.

The absence of negative outcomes associated with national vaccines could also motivate the development and production of local vaccines, even in the absence of improvements in vaccine uptake. In particular, local development and production of vaccines can lead to reduced costs, decreased foreign dependence, workforce development, and job creation, which can be highly beneficial.[38,48,49] Additionally, it can enhance both the country's internal and external reputation.[117] Moreover, if SinoCelltech succeeds in developing a 14-valent Chinese HPV vaccine, local manufacturing of this vaccine becomes even more imperative, as importing it from China could introduce additional barriers.

Limitations and further research

While this study provides novel insights into the role of national origin cues in HPV vaccine advertising, several limitations should be acknowledged. First, the sample was limited to university students in the UK, a population that may not fully reflect the diverse perspectives on vaccine trust and COO effects found in the general public. Prior research suggests that age, education level, and prior vaccine exposure significantly influence vaccine perceptions,[118–124] indicating the need for a more demographically diverse sample in future studies. Additionally, this study focused on HPV vaccines, which are well-established in the UK healthcare system. The impact of COO cues may differ for vaccines with lower public awareness (e.g., dengue, polio) or those introduced during global health crises (e.g., COVID-19). Future research should investigate COO effects in different vaccine types and cultural contexts to determine how national branding influences vaccine uptake across populations.

One key limitation of this study is the lack of a significant effect of COO cues on vaccine intentions, despite observable differences in visual attention patterns. This may suggest that vaccine brand loyalty or preexisting trust in established HPV vaccines (e.g., Gardasil, Cervarix) plays a stronger role than

COO in shaping perceptions. Additionally, because HPV vaccines are routinely included in UK immunization programs, public trust in the National Health Service (NHS) may have overshadowed COO concerns. Future research should investigate whether COO cues have a stronger influence on vaccines that lack widespread public familiarity, such as newer or underutilized vaccines.

Although our sample size aligns with typical parameters in eye-tracking studies within health communication,[54,66,93,94] it represents our primary constraint. With only 20 participants per condition, our ability to extrapolate broader conclusions is hindered by inadequate statistical power. Nevertheless, controlled experiments are inherently resource- and time-intensive. This challenge is further compounded by participant reluctance toward vaccination-related studies, making it more difficult to acquire larger sample sizes. Moreover, since 17 participants had already received the HPV vaccine at the time of the study, we cannot disregard this potential interference in the results. Despite these limitations, we assert the necessity of such experiments to uncover otherwise inaccessible insights.

While the small sample size restricts statistical generalizability, this study adopts a mixed-methods approach – integrating eye-tracking data with qualitative analysis – to explore the role of COO cues in HPV vaccine advertising. Although the advertisements were not designed using formal branding or advertising theory, the findings offer valuable preliminary insights that should be supported and extended by future research with larger, more diverse samples to establish statistical significance.

Building on these findings, future studies should explore COO effects in populations with stronger vaccine hesitancy, such as regions where mistrust in pharmaceutical companies or government health initiatives is prevalent.[125,126] Additionally, cross-cultural studies comparing COO perceptions in Western vs. non-Western countries would provide valuable insights into how national branding influences vaccine acceptance across different healthcare systems. To enhance statistical robustness, future studies should also increase sample sizes and incorporate longitudinal designs, tracking whether COO-influenced perceptions persist over time or are temporary attention shifts. These efforts will help refine public health messaging strategies and optimize vaccine advertising campaigns for global audiences.

Several uncontrolled factors may have influenced visual attention patterns. Color schemes, font size, and text complexity in the advertisements could have contributed to differences in fixation duration independent of COO cues. Additionally, participants' prior knowledge of HPV vaccination and existing vaccine attitudes may have affected their engagement with the ads. Future research should control for these confounding variables through balanced ad design and pre-exposure HPV knowledge assessments. We must recognize that visual attention, intention, and attitudes do not necessarily translate into vaccine uptake. Therefore, we recommend follow-up studies that include delayed recall tests or real-world vaccination tracking to assess whether these measures predict actual vaccine uptake decisions.

In this study, we exclusively examined the impact of a national COO cue on HPV vaccination. However, research on COVID-19 vaccines has demonstrated a negative COO effect toward Chinese and Russian vaccines, alongside a positive effect toward Western vaccines.[33–37,39–47,51–108,127–137] Consequently, we posit that investigating the influence of foreign COO cues on HPV vaccination communication, particularly tracking visual attention in advertising, would be advantageous.

Lastly, the escalating presence of anti-vaccine activism poses a risk to all vaccines.[138–139] Hence, we strongly advocate for replicating our study with various vaccines, including hypothetical vaccines for potential future pandemics.[50,51]

Author contributions

CRediT: **João Lucas Hana Frade:** Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – original draft; **Janaina de Moura Engracia Giraldi:** Project administration, Supervision, Writing – review & editing; **Talya Porat:** Resources, Software, Supervision, Writing – review & editing.

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Data availability statement

Data is available under request to the corresponding author.

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