PLOS Climate

RESEARCH ARTICLE

How advertising matters: Outdoor media strategies for increased engagement with creative climate change messages

Maxwell Boykoff[1*], **Harsha Gangadharbatla**[2], **Beth Osnes-Stoedefalke**[3]

1 Buckley Center for Sustainability Education, Department of Environmental Studies, Cooperative Institute for Research in Environmental Sciences [CIRES], University of Colorado Boulder, Boulder, Colorado, United States of America, **2** Hussman School for Journalism and Media, University of North Carolina, North Carolina, United States of America, **3** Buckley Center for Sustainability Education, Department of Theater, University of Colorado Boulder, Boulder, Colorado, United States of America

* boykoff@colorado.edu

OPEN ACCESS

Citation: Boykoff M, Gangadharbatla H, Osnes-Stoedefalke B (2026) How advertising matters: Outdoor media strategies for increased engagement with creative climate change messages. PLOS Clim 5(1): e0000645. https://doi.org/10.1371/journal.pclm.0000645

Editor: Jamie Males, PLOS Climate, UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

Received: May 12, 2025

Accepted: October 28, 2025

Published: January 21, 2026

Peer Review History: PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: https://doi.org/10.1371/journal.pclm.0000645

Abstract

Amid many contemporary communication strategies, creative advertising approaches are clearly powerful tools. Yet out-of-home (OOH) or outdoor media (OM) often receives little attention in advertising research, particularly when used in the context of climate change, sustainability and environmental issues. This research helps to bridge the gap with experimentation and analysis OOH or OM in the context of environmental messages by exploring how size, type (static versus mobile), placement, and content on advertisement engagement may shape engagement. We use data collected in a real-world field experiment in 2022–2023, garnered through two waves of data collection using QR codes and clickthrough rates on mobile smartphones. We found that larger advertisements outperformed smaller ones with the same message, that exterior bus advertisements garnered more engagement than interior advertisements, and static billboards were more engaging than the transit or bus advertisements with the same messages. Furthermore, we found that general climate change advertisement messaging gained more engagement than more specific sustainable fashion advertising messages that linked to climate change. Overall, we found that creative advertising through OOH/OM can be immensely powerful and effective in raising awareness and garnering engagement or even persuading people to take action within a wider context of advertising/PR work and climate science-policy processes and institutions facing influential carbon-based industry and climate change countermovement pressures. This experimental research has been designed and executed in order to help provide insights for ongoing campaigns for enhanced climate, environment and sustainability awareness and action. In the context of ongoing research to understand the utility of advertising – by carbon-based industry, by groups seeking to inspire greater pro-environmental behavior – our experimental work provides insights and implications for academics and practitioners who seek to

Data availability statement: All relevant data are within the paper and its Supporting information files.

Funding: The experimental advertising work was supported by the City of Boulder (MB, BO-S & HG), Boulder County (MB, BO-S & HG). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors have declared that no competing interests exist.

shape and influence pro-climate awareness and behavioral action. Together, these dynamics shape ongoing challenges of communication, (mis/dis)information-sharing, education and literacy in contemporary society.

Introduction: Creative advertising to raise awareness and inspire action in a changing climate

The year 2024 was the warmest year in nearly 150 years of recorded history [1] and the highest carbon dioxide concentrations in the atmosphere in the last 14 million years [2]. Moreover, the ten hottest years since record-keeping began have all occurred in the past decade [3] while humans have contributed to these patterns through the burning of fossil fuels and through land use patterns [4].

Carbon-based industries – coal, oil, natural gas companies, automobile manufacturers among them – have fueled and entrenched these patterns of practice, in part through their advertising, public relations (PR), media and influence campaigns over decades [5–7]. For example, Edelman global communications firm has handled public relations and advertising for several large fossil fuel companies – including ExxonMobil and Shell [8] – as well as their benefactor, investors and supporters – such as the Charles Koch Foundation [9] and the Heartland Institute [10]. They have also just been contracted by the United Nations (UN) Development Program – on behalf of the UN climate negotiations (COP30) Presidency in Brazil – to engage strategic partners, manage media relations, oversee crisis management communication plans and develop social media from the official channels of COP30 [11]. Research has pointed to these networked industries and sectors as key contributors to climate policy obstruction as Edelman and other PR and advertising agencies are the 'glue' adhering carbon-based industries with political institutions, and media organizations thereby fixing status quo views on climate actions [5,12]. While Edelman themselves declared in 2014 that they "do not accept client assignments that aim to deny climate change" [13], their connections through these kinds of contracts continue [14]. While heterogeneous in several ways, the collective of groups working together in these spaces have fed into efforts of 'climate change countermovement organizations' (CCMs). Examining these CCMs, Justin Farrell linked together a complex web of connections between industry board members, politicians, foundations, public relations firms, trade associations, ad hoc groups and think tanks, and revealed how political actors and multi-national oil and gas corporations have exerted influence over climate change policy (in)action in the US over the past several decades. This mapping helped document ongoing channels – from ExxonMobil to the Heartland Institute – through which misinformation and disinformation has demobilized constructive policy action on climate change [15].

Disinformation and misinformation refer to deceptive or inaccurate communications and content that can undermine, confuse, misrepresent and mislead understanding and comprehension about various issues. Disinformation is widely viewed as deliberate while misinformation is seen as inadvertent or unintentional propagation

of inaccuracies. In the context of climate change, disinformation and misinformation can confuse – and effectively then undermine – fundamental scientific facts that the climate is changing and humans significantly contribute to these changes. They can also erode trust in science, policy actions, institutions and relevant expert communities. Together, these demobilize engagement and action in the face of harms associated with anthropogenic climate change in the 21st century [16,17]. Yet, identifying content as "disinformation" and "misinformation" has continued to be difficult due to shifting discursive tactics [18].

Over the past decade, many scholars, groups and organizations have begun to pressure advertising and public relations companies to stop producing carbon-based industry propaganda in the face of anthropogenic climate change [19]. Yet, relationships between carbon-based interests and AD/PR agencies persist despite public pressure from groups like Climate Investigations, Check My Ads, Sleeping Giants, Clean Creatives and the Conscious Advertising Network.

As such, assertions of 'greenwashing' continue to pervade analyses of rhetoric contrasted with action in the face of contemporary climate change [20]. Such approaches are then amplified through media communications and platforms, where "circulation of climate disinformation is partly enabled by the unprecedented economic and social power of the global media system" through advertising for fossil fuel companies that can sometimes make purchased content look like positive or objective straight news reporting in their outlets [5]. These have been described as opportunistic actions where "the customer perceives that greenness is at a high level, but actual greenness is at a low level" [21, p. 341]. These ongoing activities led United Nations (UN) Secretary General Antonio Guterres to say to the UN Assembly in September 2023, "We need to hold fossil fuel companies and their enablers to account. [This] includes the massive public relations machine raking in billions to shield the fossil fuel industry from scrutiny" [22]. These actions nonetheless text 'moral boundaries' of companies [23] while challenging reputation and credibility once these strategies are revealed through network connections between advertising and firms as well as enabling organizations [24]. Yet, ongoing resistance to change is connected to several economic, societal, political and cultural factors [25]. In other words, power, profits and influence are at stake [10]. According to one World Bank estimate, carbon-based industries made US$3 billion a day in inflation-adjusted profits for last 50 years [26]. Meanwhile, global advertising revenue has been reported to have grown 5.8% to $889 billion (excluding political advertising) in 2023 [27] as the advertising industry at a global level is valued at US$1 trillion in 2025 [28,29]. There continue to be fraught relationships between advertising, public relations agency clients and environmental organizations through the present day [5]. Research has revealed that more than one hundred influencers have been hired by public relations firms to promote oil and gas clients around the world in recent years [30]. Much like lucrative carbon-based industry activities, the most lucrative advertising market is in the United States (US) [31].

Meanwhile, others have been harnessing the creative power of advertising in order to promote climate-friendly engagement and action [32]. Researchers in the areas of climate change communication and environmental communication have called for advertising academia and industry to focus their energy and resources to finding more effective ways to use the power of persuasion to influence people to engage in more sustainable behaviors among other things (e.g., [33]). One such under researched area that connects the advertising industry to the environmental movement is the out-of-home (OOH) or outdoor media (OM). Increasingly, practitioners, organizations and scholars involved in environmental movements have recognized how messaging through OOH or OM has potential power to motivate and advance pro-environmental awareness and engagement (e.g., [34–36]). Drawing on previous research (e.g., [37,38]) the current project bridges the gap in research on OOH or OM in the context of environmental messages by exploring what roles size, type (static versus mobile), placement, and content on advertising engagement (measured through QR codes) matters when using data collected in a real world field experiment.

Literature review: Mobilizing advertising power for climate change (in)action

Advertising is a powerful economic and social force that shapes individuals' beliefs, attitudes, intentions and behavior. The creative engine that drives the advertising industry can also help change beliefs, attitudes and intentions of people and

even persuade them to engage in sustainable behaviors. This represents new avenues – complementing often dominant scientific ways of knowing with emotional and affective messages – through which climate change, environment and sustainability themes can creatively be communicated in order to raise awareness and inspire engagement and action [39]. This approach also illustrates movements beyond 'information deficit model' logics (e.g., [40]) into science and environmental communication efforts that are dynamic, non-linear and complex (e.g., [41]). Before we delve into literature on the use and effectiveness of OOH advertising, let us briefly examine some research in the broader area of advertising and climate change. We draw from interactive advertising theory [42,43] that highlights the dynamic role of consumption in contemporary society, that thereby shapes the effectiveness of how messaging in interpreted in this age of earned attention, hyper-locality, persuasiveness, interactivity and attribution [44,45].

Advertising about climate change and environmental topics

Within the context of communication about climate change and other environmental issues, Joel Smith and Helene Joffe [46] found that images within print and television advertising further prompted audiences to more readily identify dangers and threats as well as help define issues and problems. Meanwhile, Anders Hansen and David Machin analyzed the use of Getty Images Holdings, Inc – a visual media company that sells stock images – in environmental advertising and found that generic green images have the ability to "promote discourses suitable for branding and marketing" while warning that such use also has the potential "effect of promoting greater consumption" ([47], p. 792). This caution was illustrated in a 'CO2 is Green' advertising campaign that ran more than a decade ago in several US major newspapers like the *Washington Post* and was funded by groups associated with carbon-based industry [48]. A few years later, the Heartland Institute rolled out a much-maligned billboard advertising campaign that compared climate 'believers' with the notorious Ted Kaczynski (the 'Unabomber') [39]. Over the past decade, ongoing and often-times more subtle narrative building through greenwashed advertising has been detected in major news outlets like *Bloomberg*, *The Economist*, *the Financial Times*, *the New York Times*, *Politico*, *Reuters*, and *the Washington Post* in recent years [20].

Outdoor advertising media effectiveness

There has been a lot of research on measuring the effectiveness of advertising messages over the last 75 years or so. Study after study in advertising literature has consistently shown advertising to be effective. In fact, a meta-meta-analysis of 44 meta-analyses of over 1,700 primary studies with more than 2.4 million subjects shows that advertising is effective [49]. Advertising effectiveness depends on several factors and can also be measured using a variety of ways. As a starting point, from the Harold Lasswell's [50] model of communication, we know the five elements that make up the act of communication include who (source) says what (message) in what channel (medium) to whom (audience) with what effect (desired outcome). While all these elements play a role in the effectiveness of advertising messages, in this study and literature review, we will focus on two factors that influence advertising effectiveness and the different ways in which effectiveness is measured. The two factors we focus on that potentially impact the measurement of advertising effectiveness are: (1) the advertising message itself and (2) the advertising media that carries the message [51].

The role of message format in advertising effectiveness has been extensively studied in various media including but not limited to print advertising [52], radio advertising [53–56], television advertising [57,58], internet advertising [59], in-game advertising [60], and even outdoor advertising [61]. However, there is limited research done in the area of outdoor (OOH/OM) advertising effectiveness compared to other media and even fewer studies that examine outdoor in combination with other media, specifically mobile phones. Outdoor (OOH/OM) when combined with mobile phones (e.g., QR codes) offers unique measurements opportunities to test empirically the effectiveness of various message formats and factors.

There have been several review and conceptual articles on the role of message formats and other creative elements in outdoor advertising effectiveness, but one of the first empirical studies to examine the role of such factors is by Bhargava et al. [62]. Using data from 282 campaigns, Bhargava et al. [62], found that the factors that influence the effectiveness

of advertisements in the outdoor medium may be different from those of other media making outdoor a unique medium. More specifically, in terms of executional factors, the use of photography or artwork in outdoor advertising (positively), use of humor (positively), copy length (negatively), and the type of the outdoor medium itself all are significantly related to recall [62]. Similarly, Donthu et al. [61], found in a study of 142 respondents who commute on a daily basis on a stretch of highway with ten billboards that effectiveness of outdoor advertisements is influenced by their location, position, number of words, color, respondent involvement, and attitudes. Unfortunately, Donthu et al. [61], did not examine the role of the size and type of the outdoor advertising in influencing advertising effectiveness.

Exterior bus advertising is considered a type of a broader subset of outdoor (OOH/OM) advertising often referred to as transit advertising. Transit advertising has a long history with the first advertisement attached to a streetcar by its conductor in New York in 1831 [63]. In general, research suggests that for transit advertising to be effective, the advertisements need to be simple, bold, catchy, and legible [64]. However, there are very few studies that examine the effectiveness of exterior bus advertising, particularly in the context of environmental messages. Of the few studies that examined the effectiveness of exterior bus advertising, Prendergast & Hang [63], found that the advertisements that drew commuter attention and resulted in higher recall were colorful, interesting and have some feature that make it noticeably different from other advertisements. Again, this study, which was done in Hong Kong, used personal interviews for data collection relying on individuals' faulty memory and the potential influence of demand effects. More specifically, bus advertising is known for its potential for high visibility and frequency of exposure making it a cost-effective and powerful way of increasing awareness [65].

In more recent studies, message processing and attention capacity of outdoor advertising has been examined more closely in comparison to other forms of advertising. Given that outdoor is a background medium, in order to grab attention and have the audience process such messages, advertisers often employ a unique set of executional strategies. Wilson [66] outlines some of these unique executional strategies such as novel stimuli, visual saliency, repetition, situational and contextual relevance, and consumer involvement as factors that influence consumer processing of outdoor messages and the effectiveness of such messages in influencing attitudes and behaviors. Among these factors, repetition is shown to be related to shifts in attitudes across different types of OOH advertising [35,67].

The psychological mechanisms that drive the effectiveness of outdoor advertising can be found in the Elaboration Likelihood Model (ELM), which posits that there are two routes to persuasion—central (high elaboration) or peripheral (low elaboration)--and given that OOH/OM is a background medium, information processing usually takes the low-elaboration (short exposure, secondary task) route, so the peripheral cues (visuals, large text and logo size, bright screens and colors, and repetition) are what often drive persuasion [68]. Oftentimes these peripheral cues in outdoor advertising are what that attract consumer attention and increase recall/memory even though the attitude shifts linked to peripheral route are considered somewhat short-term unless there is an increase in repetition, which again explains why OOH/OM advertising effectiveness is linked to repetition [69].

Similar to ELM, the Hierarchy-of-Effects model (HoE) has often been used as a theoretical framework to explain the effectiveness of outdoor advertising [70,71]. The Hierarchy-of-Effects model sometimes referred to as DAGMAR model in the industry follows three stages of persuasion: Cognitive, Affective and Conative phases. In the cognitive (or thinking) phase, the goal is to create awareness and the outdoor medium has the biggest potential in this phase given OOH/OM's high reach and repeated exposures. Research suggests that bold, bright, large text, and other attention-grabbing executional techniques used in OOH advertising are often effective in creating awareness [66]. In the affective (emotional) phase, the goal is to produce a favorable shift in attitudes, preferences and liking. Given the peripheral route to persuasion that OOH advertising is associated with the eye-catching images, visuals, and locational/situational cues should generate a positive shift in attitudes despite their short-term nature [69,72]. And lastly, in the conative phase, the goal is to generate action. OOH advertising can be effective in that gentle nudge for call to action whether by creating a sense of urgency (or FOMO) through "next exit," "last chance," or "text now!" messages or by mechanisms that are easily integrated with

mobile devices like QR codes. Lastly, speaking of QR codes, the use of newer technologies in outdoor advertising is also a subject of recent studies. For instance, Išoraitė & Gulevičiūtė [73] note that outdoor advertising can now be presented in interactive, engaging and immersive ways that influence the ultimate effectiveness of these messages. In investigating the various elements of outdoor advertising that show the most influence on consumer purchase decisions, they found that the integration of such new technologies (virtual and augmented displays), outdoor advertising dominated by visual and animated content, brightening of outdoor screens, and large letters with brand names were found to be the most critical factors in influencing consumer purchase decisions [73].

Despite these recent efforts to investigate the effectiveness of outdoor (OOH/OM) advertising, particularly with new technologies, one limitation of previous studies in this area is that most of them employ audience responses of recall, attitudes and intentions, and/or traditional measures of outdoor effectiveness GRPs etc., which are at best estimates rather than actual measures of effectiveness. Using the power of QR codes and mobile phones, it is now possible to measure the actual level of engagement with outdoor advertisements, which is precisely what the current study does. Furthermore, almost all previous studies have examined billboards as the dominant form of outdoor advertising leaving room for inquiry into other outdoor formats such as bus advertising. In addition, the use of outdoor (OOH/OM) for environmental messages is also another under researched areas. Despite these limitations, previous studies do provide a direction and scope for us to propose some research questions to guide our own exploratory study.

Based on the review of the limited research in this area, particularly in the context of environmental message, we developed the following research questions to carry out a systematic study on the how size, type, placement, and content shaped engagement [37]. To answer our research questions, we developed a field experiment using data collected real time through QR codes while the buses were in transit.

RQ1: What is the relationship between environmental advertisement size and engagement?

RQ2: What is the relationship between environmental advertisement placement (interior versus exterior) and engagement?

RQ3: How does message content (general climate messaging versus sustainable fashion messaging) impact engagement?

RQ4: For the same advertisement messages, how does mobility (static billboards versus bus advertisements) impact engagement?

RQ5: How is engagement impacted by the presence of a human in advertisements versus non-human content?

Methods: Context and study design

The current study focuses on understanding the role of message and some content factors in the outdoor medium for environmental communication. In other words, this project bridges tried and tested advertising media strategies with tenets of environmental communication.

This study was based on a real-world outdoor campaign in the Southwest region of the United States and data was collected using QR codes and commuters' mobile phones. The median age in this area is 37.5 years old, a poverty rate of about 11%, unemployment rate of 4.5% and an average commute time for workers at 23.2 minutes through various modes of transportation. Ethnic demographics are about 75% white, 15% Hispanic/Latino, 5% Asian, and 1% Black/African American, according to US Census Data. There were two sets of public bus advertisements that began circulating November 1, 2022, (Figs 1–3) and December 1, 2022, respectively (Fig 4). There were then two sets of billboard advertisements that were posted at the same time as the December 1 set of bus advertisements (Figs 5 and 6). Each was posted for 90 days. Each advertisement contained QR codes that linked to Spanish-and English-language action

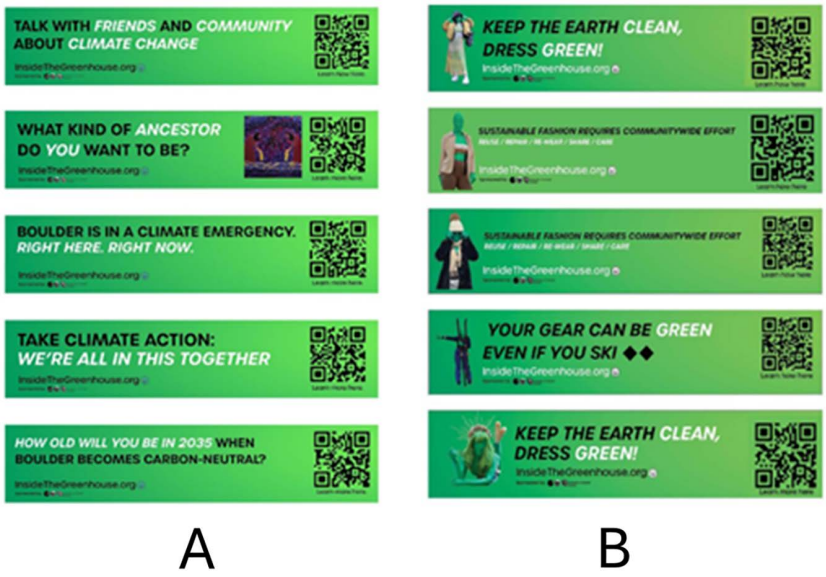

Fig 1. 'King Size' advertisements that appeared outside buses for 90 days beginning November 1, 2022.

https://doi.org/10.1371/journal.pclm.0000645.g001

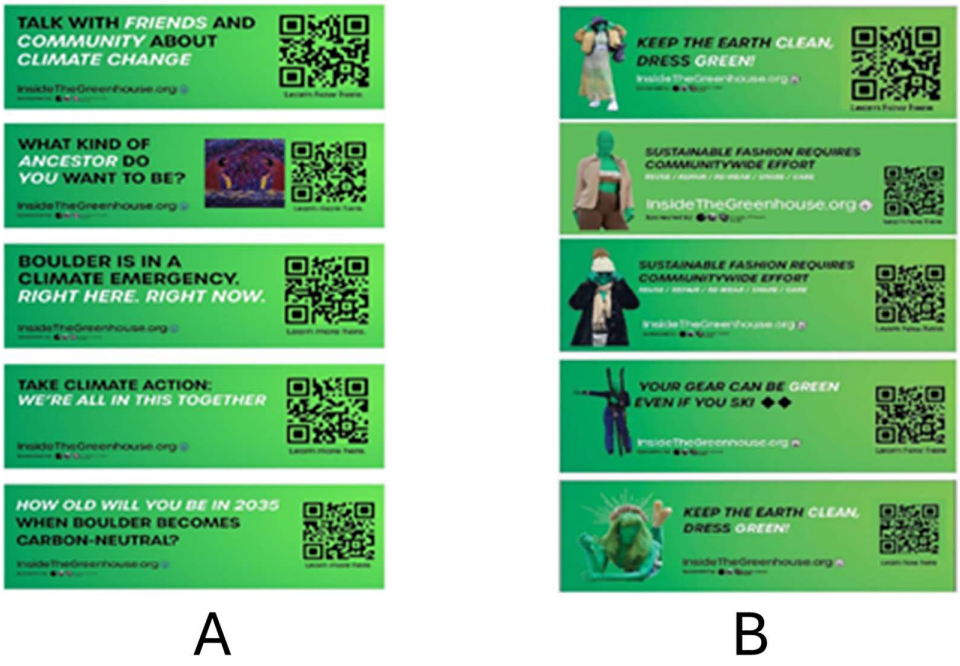

Fig 2. 'Queen Size' advertisements that appeared outside buses for 90 days beginning November 1, 2022.

https://doi.org/10.1371/journal.pclm.0000645.g002

webpages respectively. Potential confounds were addressed by the regular circulation/routes of each bus through different locations in the area each day and at randomized times of day, as determined by the Regional Transportation District (RTD) without regard for the advertisements on the buses. Moreover, all QR codes were designed to be large

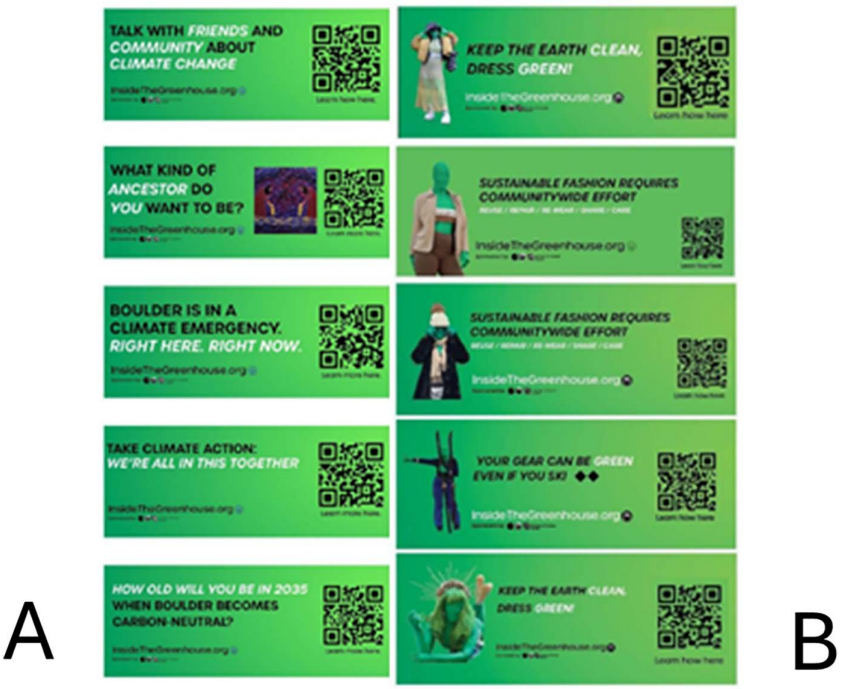

Fig 3. 'Interior' advertisements that appeared inside buses for 90 days beginning November 1, 2022.

https://doi.org/10.1371/journal.pclm.0000645.g003

enough for phones to capture the link at any usual distance from the roadways. We obtained access to these advertising spaces through a contract with a local advertising company, no additional permits were required. There were two types of messages created and then tested: (1) general messaging about climate change, and (2) messaging relating to climate change and sustainable fashion. In round one (beginning November 1), the messages were repeated on bus installations in two sizes ('King' and 'Queen' exterior, and interior). The project was a collaboration with several entities, and therefore, the messaging was co-produced, discussed, revised and ultimately agreed upon before final publication in each of the two rounds or 'waves' of advertisements.

Using the nomenclature of the advertising industry Figs 1 and 4 show 'King Size' advertisements (30 inches by 144 inches each) that appeared on the outside of buses. Fig 2 shows 'Queen Size' advertisements (30 inches by 88 inches each) that also appeared on the outside of buses. Fig 3 shows 'Interior' advertisements (11 inches by 28 inches each) that appeared inside buses.

Figs 5 and 6 show billboard advertisements that appeared in two locations in both Spanish and English. The billboards in Fig 5 (10 feet 6 inches by 22 feet 9 inches each) appeared along two highways near the city in the Southwest region. The billboards in Fig 6 (10 feet 6 inches by 22 feet 9 inches each) appeared along another set of highways near another city in the region.

For additional background, pilot work for this project began in early 2022 with climate change advertising placed in three newspapers in the US South: *the Selma Times-Journal* in Selma, Alabama (appearing March 9), *the Brunswick News* in New Brunswick, Georgia (appearing March 19) and *the Harrison Daily Times* in Boone County, Arkansas (appearing July 23) (Fig 9). *Green Suits Your Fashion* was enacted in the Spring of 2021 with an upper- division undergraduate Creative Climate Communication course taught at a large Southwest university (Figs 7 and 8). For this assignment, students were asked to (1) sustainably source an aspirational outfit (thrifting, gifting, clothing swap, and beyond),

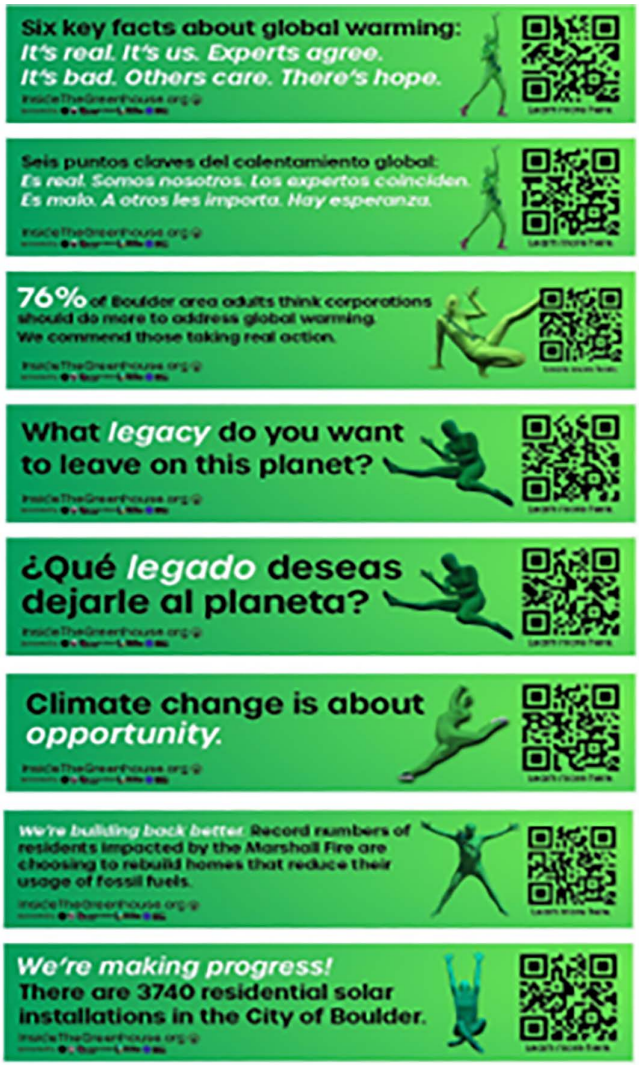

Fig 4. 'King Size' advertisements that appeared outside buses for 90 days beginning December 1, 2022, (second phase of data collection).

https://doi.org/10.1371/journal.pclm.0000645.g004

(2) photograph themselves in the outfit while wearing a full green morph suit underneath, and (3) add an environmental message about the importance of sustainable or "slow fashion" (the opposite to fast fashion), and (4) share all of this with at least ten people within your circle of community. Instead of the hopeful outcome of 40 students reaching 400 people with this environmental message, when we tallied up all the "hits" and "reaches," we reached over 5000 people. Beyond that, two students took the initiative to apply for external funding to create bus advertisements with these images and accompanying messages and plastered these images through the interior spaces of the buses, which are frequently used by the university students. The use of green suits has evolved as a mode of embodied climate communication that has had several iterations, all "green lighting" various resilience and sustainability issues. The use of the human body in visual climate communication attracts the eye, as research demonstrates that we are more attracted to people than pie charts [74, p. 42].

This helped build coordination among the design teams (that included nine students as co-creators at various stages) and organizational partners to establish protocols for assessment and to explore further text and images messaging and

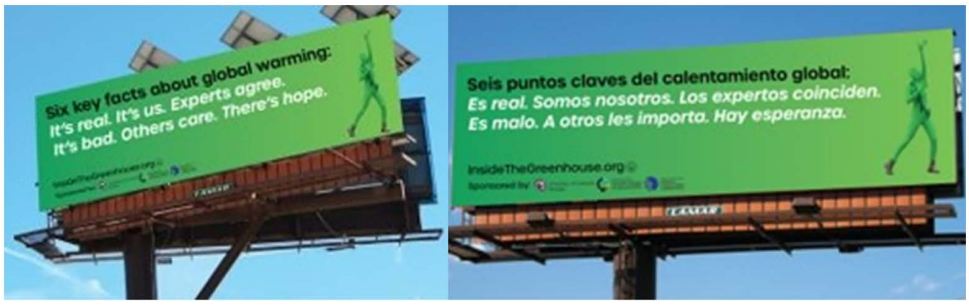

Fig 5. English- and Spanish-language advertisements that appeared on billboards for 90 days beginning December 1, 2022, on highways.

https://doi.org/10.1371/journal.pclm.0000645.g005

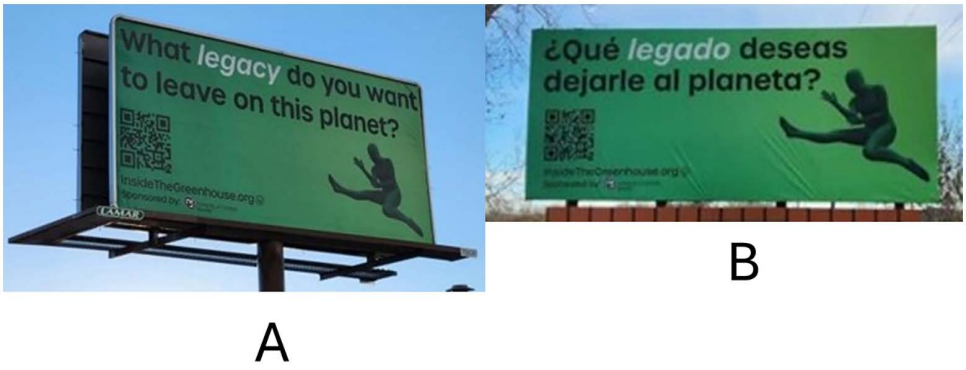

Fig 6. English- and Spanish-language advertisements that appeared on billboards for 90 days beginning December 1, 2022, on highways.

https://doi.org/10.1371/journal.pclm.0000645.g006

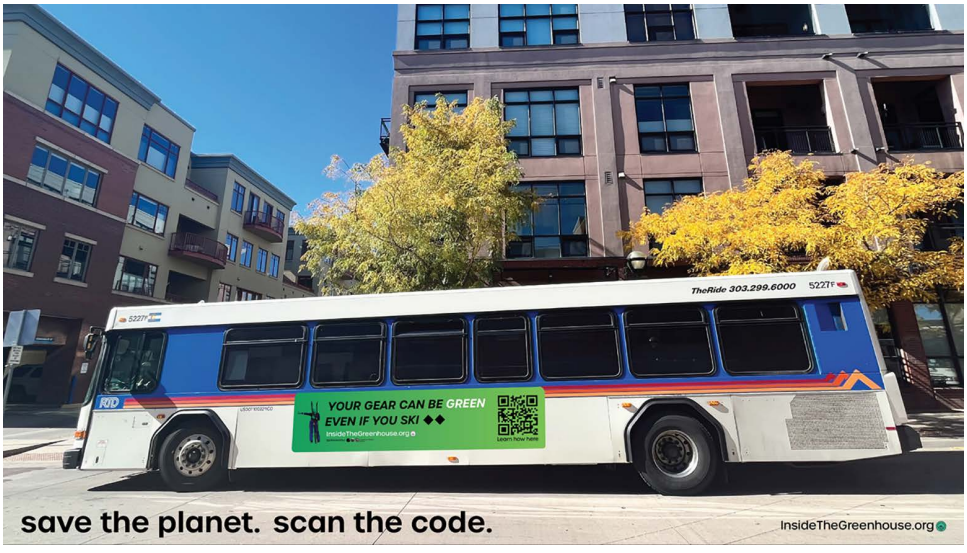

Fig 7. An example of a bus with sustainable fashion and climate change messaging on a bus running within the city area for 90 days in late 2022 and early 2023.

https://doi.org/10.1371/journal.pclm.0000645.g007

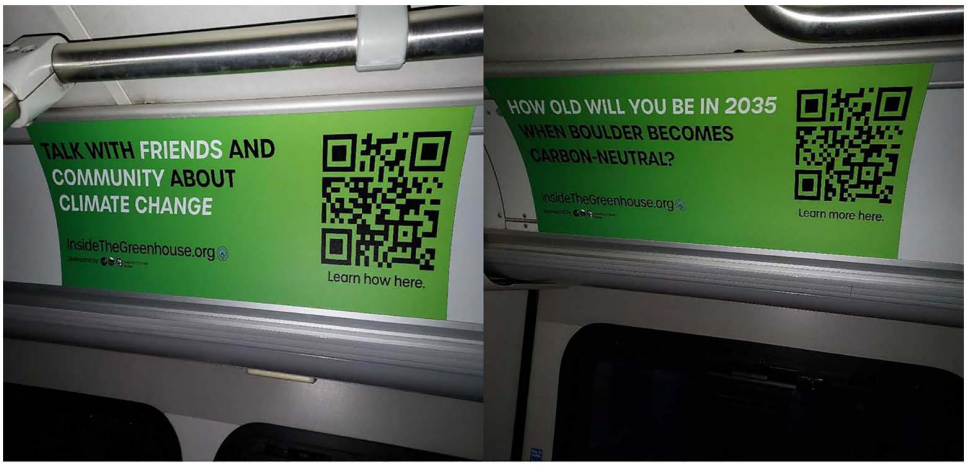

Fig 8. Examples of interior bus advertising with general climate change messaging on a bus running in the city area for 90 days in late 2022 and early 2023.

https://doi.org/10.1371/journal.pclm.0000645.g008

answer research questions for this OOH/OM bus and billboard research study. The following figures show all the images used in the OOH/OM advertisements. These advertisements represent the different sizes (KING v. QUEEN), types (static billboards v. transit advertising), placements (exterior v. interior), and some content aspects (e.g., presence of humans v. non-humans) that our research questions are based on and, for all the advertisements, the number of QR code scans serves as a measure of advertising engagement.

Analysis and results

The study first assembled descriptive statistics and measured engagement through QR codes, which was captured in raw numbers (column B of Table 1 below) as well as by the percentage of overall QR code engagement (column C). Overall, there were 527 engagements through the QR codes (King (round one): N = 382; King (round two): N = 35; Queen: N = 45; Interior: N = 22; Billboards: N = 43). These engagements are indicative of the wider population of the area and not representative. They also detect a form of response (QR scan) to the stimuli (advertisements), yet there remain complex, dynamic and non-linear relations ongoing with attitudes, perspectives, beliefs and behaviors [75]. So these results are treated with cautious explanatory power. A breakdown of engagement for each individual advertisement can be found in Table 1.

Then, to answer our research questions, we conducted a series of independent samples t-tests with QR-code scans, which measured the engagement, as the test variable. RQ1 relates to the role of advertisement size on engagement. As noted earlier, there were two different exterior advertisement sizes (KING and QUEEN) and data was collected in two different waves. In order to answer the first research question, we needed the advertisement messages to be the same across different sizes, which resulted in a comparison of QR code responses for KING and QUEEN sized advertisements. As noted in Table 1, the messages across KING and QUEEN messages were not only the same, but the data was also collected during the same time period. Table 2 below summarizes the results of the t-test with QR-code scans as the test variable and the advertisement size as the grouping variable (KING *versus* QUEEN).

As noted in Table 2, there were significant differences in the scanned QR-codes for advertisement size KING (M = 38.2, SD = 21.4) and QUEEN (M = 4.5, SD = 4.5); t (18) =4.8, p < .001. This answers our research question that engagement is a

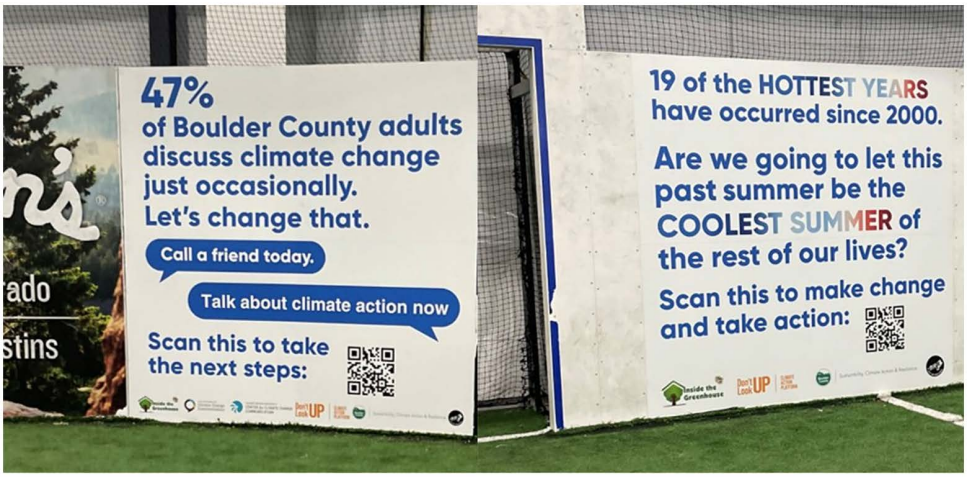

Fig 9. Examples of pilot work: Advertising at an Indoor Soccer facility in Southwest region beginning September 21, 2022.

https://doi.org/10.1371/journal.pclm.0000645.g009

function of the advertisement size with the larger KING size resulting in almost 8.4 times more engagement than smaller size QUEEN for the same set of environmental advertisements.

Our second research question, RQ2, asks if the placement (interior versus exterior) has an impact on the engagement as measured through the QR-code scans. All the interior advertisements are listed under Fig 3 above with the exterior advertisements with same message listed in Figs 1 and 2. In order to test whether the placement of the advertisement had any effect on ad engagement, we first ran an independent samples t-test between interior advertisements and KING size exterior advertisements. And then ran a similar t-test with QUEEN size exterior advertisements and interior advertisements as grouping sizes. Results are outlined in Table 3a and 3b below.

Comparing both exterior and interior advertisements with the same message, it appears that exterior advertisements, both KING and QUEEN sizes, outperformed the interior advertisements with the exact same message in terms of QR-code scans. However, differences in engagement were significantly higher for the larger sized exterior KING advertisements ($M = 38.2$, $SD = 21.4$) in comparison to interior advertisements ($M = 1.8$, $SD = 1.3$); $t(18) = 5.3$, $p < .001$ than for the QUEEN sized exterior advertisements ($M = 4.5$, $SD = 4.5$) in comparison to interior advertisements ($M = 1.8$, $SD = 1.3$); $t(18) = 1.7$, $p < .001$. In other words, exterior KING size advertisements outperformed interior advertisements with the exact same messages by 21.2 times while QUEEN size exterior advertisements outperformed interior advertisements with the exact same message by only 2.5 times. This indicates that more than the placement of the advertisement (exterior *v.* interior), the size plays a significant role in generating more engagement through QR-codes.

RQ3 deals with the impact of the message content itself on engagement with advertisements. More precisely, it asks whether general climate change messages are more or less engaging than specific sustainable fashion messages. People interested in sustainable fashion may be a subset of the larger population of people interested in climate change action itself. Thus, we expected than general climate message would be more engaging than sustainable fashion ones. Within the KING and QUEEN advertisement sizes, the first five messages relate to general climate change action and the second set of five advertisements relate to sustainable fashion (please refer to Table 1). To answer RQ3, another series of independent samples t-tests were run with QR-code scans as the test variable and general versus sustainable fashion as the grouping variable within both KING and QUEEN advertisement size categories. Results are summarized in Table 4a and 4b below.

Table 1. QR code scans by advertisement.

Categories & Advertisements/Messages	QR-code scans (counts)	QR-code scans (% of total in category)	QR-code scans (% of total overall)
KING (round one)			
1.a.1 Talk with friends and community about climate change	55	14.4	10.4
1.a.2 What kind of ancestor do you want to be?	62	16.2	11.7
1.a.3 Boulder is in a climate emergency. Right here, right now.	61	16.0	11.5
1.a.4 Take climate action: we're all in this together.	58	15.2	11
1.a.5 How old will you be in 2035 when Boulder becomes carbon-neutral?	54	14.1	10.2
1.b.1 Keep the Earth clean, dress green! (version 1)	23	6.0	4.3
1.b.2 Sustainable fashion requires communitywide effort (version 1)	21	5.5	3.9
1.b.3 Sustainable fashion requires communitywide effort (version 2)	20	5.2	3.7
1.b.4 Your gear can be green even if you ski	7	1.8	1.3
1.b.5 Keep the Earth clean, dress green! (version 2)	21	5.5	3.9
KING (round two)			
5.a Six key facts about global warming…	4	11.4	.7
5.b Seis puntos claves del calentamiento global…	3	8.5	.5
5.c 76% of Boulder area adults think corporations…	3	8.5	.5
5.d What legacy do you want to leave on this planet?	6	17.1	1.1
5.e¿Qué legado deseas dejarle al planeta?	6	17.1	1.1
5.f Climate change is about opportunity	3	8.5	.5
Categories & Advertisements/Messages	**QR-code scans (counts)**	**QR-code scans (% of total in category)**	**QR-code scans (% of total overall)**
5.g We're building back better…	5	14.2	.9
5.f We're making progress!...	5	14.2	.9
QUEEN			
2.a.1 Talk with friends and community about climate change	2	4.4	.3
2.a.2 What kind of ancestor do you want to be?	7	15.5	1.3
2.a.3 Boulder is in a climate emergency. Right here, right now.	15	33.3	2.8
2.a.4 Take climate action: we're all in this together.	6	13.3	1.1
2.a.5 How old will you be in 2035 when Boulder becomes carbon-neutral?	0	0	0
2.b.1 Keep the Earth clean, dress green! (version 1)	6	13.3	1.1
2.b.2 Sustainable fashion requires communitywide effort (version 1)	1	2.2	.18
2.b.3 Sustainable fashion requires communitywide effort (version 2)	6	13.3	1.1
2.b.4 Your gear can be green even if you ski	0	0	0
2.b.5 Keep the Earth clean, dress green! (version 2)	2	4.4	.3
INTERIOR			
3.a.1 Talk with friends and community about climate change	4	22.2	.7
3.a.2 What kind of ancestor do you want to be?	1	5.5	.18
3.a.3 Boulder is in a climate emergency. Right here, right now.	2	11.1	.3
3.a.4 Take climate action: we're all in this together.	2	11.1	.3
3.a.5 How old will you be in 2035 when Boulder becomes carbon-neutral?	3	16.6	.5
3.b.1 Keep the Earth clean, dress green! (version 1)	1	5.5	.18
3.b.2 Sustainable fashion requires communitywide effort (version 1)	0	0	0
3.b.3 Sustainable fashion requires communitywide effort (version 2)	2	11.1	.3
3.b.4 Your gear can be green even if you ski	3	16.6	.5
3.b.5 Keep the Earth clean, dress green! (version 2)	0	0	0

(Continued)

Table 1. (Continued)

Categories & Advertisements/Messages	QR-code scans (counts)	QR-code scans (% of total in category)	QR-code scans (% of total overall)
BILLBOARDS			
6.a Six key facts about global warming…	2	4.6	.3
6.b Seis puntos claves del calentamiento global…	13	30.2	2.4
Categories & Advertisements/Messages	**QR-code scans (counts)**	**QR-code scans (% of total in category)**	**QR-code scans (% of total overall)**
7.a What legacy do you want to leave on this planet?	12	27.9	2.2
7.b¿Qué legado deseas dejarle al planeta?	16	37.2	3.0

https://doi.org/10.1371/journal.pclm.0000645.t001

Table 2. Result of independent samples T-test (test variable = QR-code scans) for advertisement sizes (KING *versus* QUEEN).

	CAT	N	Mean*	Std. Deviation	Std. Error Mean
scans (counts)	KING	10	38.20	21.441	6.780
	QUEEN	10	4.50	4.577	1.447

*mean differences sig at $p < .001$.

https://doi.org/10.1371/journal.pclm.0000645.t002

From Table 4a and 4b, we can see that advertisement engagement was higher for general climate change action messages than for sustainable fashion messages. However, the results were statistically significant for only the KING size advertisements. More precisely, within the KING size advertisements category, general climate change action advertisements ($M = 58$, $SD = 3.5$) were more engaging than sustainable fashion messages ($M = 18.4$, $SD = 6.4$); $t(8) = 12.01$, $p < .001$. Or in other words, the general climate change action messages were 3.1 times more engaging than the sustainable messages within the same advertisement size category of KING. This result needs to be further investigated as within the QUEEN size category even though the general climate change action advertisements were twice as engaging as sustainable fashion messages, this finding was not statistically significant at $p < .001$ level.

RQ4 asks about the difference in engagement between static billboards and mobile bus advertisements for the same advertising messages. From Table 1, one can see that the messages on the billboards and KING size bus advertisements that ran during our second phase of data collection are identical. Since there were four billboards, the four KING size advertisements that ran during second phase with identical messages were chosen for running an independent samples t-test with these two—billboards and phase two KING advertisements—as the grouping variable and QR-code scans as the test variable was conducted. Results are summarized in Table 5 below.

Table 3. (a) Result of Independent Samples T-test (test variable = QR-code Scans) for Ad Placement (exterior KING *versus* INTERIOR). (b) Result of Independent Samples T-test (test variable = QR-code scans) for Advertisement Placement (exterior QUEEN *versus* INTERIOR).

	CAT	N	Mean*	Std. Deviation	Std. Error Mean
scans (counts)	KING	10	38.20	21.441	6.780
	INTERIOR	10	1.80	1.317	.416
scans (counts)	QUEEN	10	4.50	4.577	1.447
	INTERIOR	10	1.80	1.317	.416

*mean differences sig at $p < .001$.

https://doi.org/10.1371/journal.pclm.0000645.t003

Table 4. (a) Result of Independent Samples T-test (test variable = QR-code Scans) for Message Content (general climate change action *versus* sustainable fashion) within KING size advertisements. (b) Result of Independent Samples T-test (test variable = QR-code Scans) for Message Content (general climate change action *versus* sustainable fashion) within QUEEN size advertisements.

	CAT	N	Mean*	Std. Deviation	Std. Error Mean
scans (counts)	KING-general climate change action	5	58.00	3.536	1.581
	KING-sustainable fashion messages	5	18.40	6.465	2.891
	CAT	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
scans (counts)	QUEEN-general climate change action	5	6	5.788	2.588
	QUEEN-sustainable fashion messages	5	3	2.828	1.265

*mean differences sig at p < .001.

mean differences NOT SIG.

https://doi.org/10.1371/journal.pclm.0000645.t004

Table 5. Result of Independent Samples T-test (test variable = QR-code Scans) for static (billboards) *versus* bus advertisements with identical messages.

	CAT	N	Mean*	Std. Deviation	Std. Error Mean
scans (counts)	Bus Advertisements	4	4.75	1.5	.750
	Billboards	4	10.75	6.076	3.038

*Mean differences significant at p=.052 level.

https://doi.org/10.1371/journal.pclm.0000645.t005

For identical messages, billboards (M = 10.75, SD = 6.06) generated more advertisement engagement in terms of QR-code scans than bus advertisements (M = 4.75, SD = 1.5); t(8) = - 1.917, p = 0.052. This suggests that static advertisements (billboards) are almost 2.5 times more effective in generating engagement than bus advertisements, which are constantly on the move.

Lastly, within all of the outdoor size categories and interior advertisements, half the advertisements featured a human and the other half non-human content. Our last research question asked whether the presence of a human increases or decreases engagement with the advertisement in terms of the QR-code scans generated. We combined all advertisements across categories into human and non-human messages and ran an independent samples t-test with QR- code scans as the test variable. Table 6 below presents the result of this analysis.

In all, 27 advertisements featured a human, and 15 advertisements featured non-human content. Although there were differences in the level of engagement with advertisements with humans (M = 15.19, SD = 21.2) and advertisements without humans (M = 7.53, SC = 8.86), these differences were not statistically significant at p < 0.05; t(40) = 1.32, p = 0.096.

Table 6. Result of Independent Samples T-test (test variable = QR-code Scans) for advertisements with humans *versus* advertisements with non-human messages.

	CAT	N	Mean*	Std. Deviation	Std. Error Mean
scans (counts)	Human in Advertisements	27	15.19	21.2	4.08
	No human in Advertisements	15	7.53	8.86	2.28

*Mean differences significant at p = .09.

https://doi.org/10.1371/journal.pclm.0000645.t006

To summarize, the results of this study showed that engagement significantly increased with larger advertisement size (see Table 7 below). This advertisement size was further influenced by placement (inside and outside) though that placement was not found to be significant on its own. We found that larger advertisements with general climate messages earned significantly more engagement than more specific sustainable fashion messaging linked to climate change during this time. We also found that static billboards earned greater engagement than moving advertisements. Last, our advertising experimentation did not result in significantly more human or non-human content engagement during this period of data collection. Placing these results into the wider context of intertwined advertising/PR work and climate science-policy processes and institutions facing influential carbon-based industry and CCM pressures that we outlined above, we offer some caution: the findings we have detected here provide insights to take forward into ongoing analysis of related challenges regarding communication, (mis/dis)information-sharing, education and literacy in these times.

Discussion: Harnessing advertising power for pro-environmental engagement and action

In 2023, the New Zealand-based conservation organization 'Forest & Bird' held an online contest to vote for the New Zealand 'bird of the century' [76]. On the other side of the world, US-based comedian John Oliver learned of the contest, and began an environmentally tinged OOH/OM advertising campaign in support of a water bird called the pūteketeke. With the power of his celebrity influence and with the creative OOH/OM advertising campaign in many cities around New Zealand as well as the US, Japan and India, the Australasian crested grebe with black, brown and white feathers took the prize in a landslide contest [77]. Through creativity and humor, John Oliver and his team demonstrated the power of OOH/OM advertising for engagement and action. This episode also drew attention to the fact that over 80% of native New Zealand birds are on the country's threatened species list: that was a reality that the group Forest & Bird sought to raise awareness about and this OOH/OM advertising campaign illustrated how this became possible [78].

Similarly, this research sought to more understand and harness the power of creative advertising done in the often ignored medium of OOH/OM, particularly to raise awareness and inspire engagement and action. The current study, using real world data collected from an OOH/OM campaign, works to advance our understanding of OOH advertising effectiveness within the context of environmental movements (e.g., [79]). It also works to combat the ubiquity and influence of fossil fuel company and internal combustion engine advertising in contemporary society [12] as it creatively communicates

Table 7. Summary of results (Means for various categories).

Category	Count	Mean
KING	10	38.20
QUEEN	10	4.50
KING	10	38.20
INTERIOR	10	1.80
QUEEN	10	4.50
INTERIOR	10	1.80
KING-general climate change action	5	58.00
KING-sustainable fashion messages	5	18.40
QUEEN-general climate change action	5	6
QUEEN-sustainable fashion messages	5	3
Bus Advertisements	4	4.75
Billboards	4	10.75
Human in Advertisements	27	15.19
No human in Advertisements	15	7.53

https://doi.org/10.1371/journal.pclm.0000645.t007

through a combination of text and imagery that swirls and competes for attention in public life (e.g., [80]). On this individual level, differences between our knowledge/attitudes and behaviors – brought forward at times by creative advertising – may illustrate the chasm between what we know we *ought* to do, and what we actually do. This has often been called the 'attitude-behavior' and 'value-action' gap (e.g., [81,82]).

These creative actions are happening in many places by different approaches from practitioners such as Futerra, Creatives for Climate, the Dutch Green Health Alliance, Media Bounty, and Brandalism as examples. While these approaches vary considerably – from pressuring large PR firms to creating subversive and clandestine street art – the researchcommunity must still work to help understand their influence and efficacy in the public sphere. This experimental research has been designed and executed in order to help provide insights for ongoing campaigns for enhanced climate, environment and sustainability awareness and action.

Research has already established the importance of location and size in OOH/OM advertising (e.g., [37]). Our study's findings further provide insights into how size matters when it comes to OOH/OM advertising in general, as well as in relation to climate, sustainability and environmental topics. The larger advertisements in our study received over 8 times the engagement that smaller sized advertisements for environmental advertisements with the exact same message. When it comes to placement, exterior advertisements garnered more engagement than interior advertisements, again, for the exact same content in the advertisements. In terms of mobility, static billboards were much more engaging in terms of QR code scans than the mobile transit or bus advertisements with the exact same message. This could be explained by the fact that maybe getting a QR code scan on a moving bus is more difficult than from a static billboard. Lastly, in terms of message content factors, general climate change advertisements gained more engagement than specific sustainable fashion messages. The results were inconclusive when it comes to the use of human in environmental advertisements.

The study presents numerous implications for academics, practitioners, and climate change activists. First, OOH/OM deserves more attention from researchers in our field, particularly with the advent and proliferation of technologies like QR codes that combine the use of mobile devices as a way of measuring OOH advertising effectiveness. For practitioners, the study provides empirical evidence for media planning strategies such as opting for larger size static advertisements instead of, say, smaller interior bus advertisements for similar CPM rates. The biggest implications are for climate change communicators who often employ shocking or unconventional strategies to raise awareness (e.g., throwing fake blood on fur coats or throwingpaint at famous artworks). Our study suggests that creative advertising through OOH/OM can be very effective in raising awareness or garnering engagement or even persuading people to take action. Perhaps a better strategy for activists is to raise funds or enlist celebrities for creative OOH/OM campaigns like in the "Forest and Bird" example above.

While our study is unique in combining OOH with mobile devices as a way of collecting real world data (QR codes) from an actual OOH/OM campaign in an environmental context, it does present some limitations worth noting here. For instance, the data collection and our OOH/OM campaign is restricted to one geographic area in the Southwest region, so the results present some issues of external validity. The extent of advertising and data gathering were a function of capacity through the limited funding that was available for this experimentation. Nonetheless, these results provide insights for other markets going forward. Generalizing these findings, in other contexts the engagement numbers will differ from market to market, but we posit that the trends found here as a function of size, placement and content may be similarly evident in other contexts. Furthermore, future research could examine the extent to which engagement with advertising (as detected by QR scans) led to engagements (short-term or sustained) in forms such as pledges, financial contributions, demonstration/protest and other actions. Lastly, we did not control for time and frequency of exposure to advertisements, there was no control group or comparisons with other locations, sample sizes were small, and we collected no demographic or other types of information from the people using their devices to scan the QR codes for privacy and security concerns—all of these severely limit the external validity of our findings.

Regardless of these limitations, we feel that our study is a necessary first step for further research that involves real world data collected in the field, something that is not well represented in academic literature on OOH advertising

particularly in environmental communication context. Furthermore, our goal with this study is not to generalize our findings, but to rather explore into the relationship between various factors and OOH advertisingeffectiveness in an environmental context to provide the necessary groundwork for future generalizable studies.

Our study was designed to further our understanding of the role and effectiveness of OOH/OM advertising in the environmental communication, as well as to inspire further research and practitioner activity and consequent insights for ongoing considerations of how to harness the power of advertising for climate change, sustainability and environment action. We look forward to seeing how others build on our findings as pro-environmental advertising communications experimentation continues in varied political economic contexts and in a wider communications environment.

Supporting information

S1 Data. Supporting information.
(XLSX)

Acknowledgments

We thank partners Emily Sandoval, Julie Causa and Jonathan Koehn from City of Boulder and partners Susie Strife and Christian Hermann from Boulder County for their collaboration throughout the project. We also thank Katerina Fragos, Emma Stewart and Eileen Chen from Netflix and Scott King from Mission Zero for their involvement in pilot work. In addition, we thank Presley Church (Cornell University), Catherine Adams (Ohio State University), Edward Maibach (George Mason University), Anthony Leiserowitz (Yale University), and Nancy Yoder, Patrick Chandler, Alyssa Wells, Jennifer Parker, Jon Leslie, Lori Call, Matilda Eriksson, Naia Ormaza Zulueta, and Elizabeth Woolner (each at the University of Colorado Boulder) for their contributions at various stages of this content creation, experiment and analysis.

Author contributions

Conceptualization: Maxwell Boykoff, Harsha Gangadharbatla, Beth Osnes-Stoedefalke.

Data curation: Maxwell Boykoff.

Formal analysis: Maxwell Boykoff, Harsha Gangadharbatla, Beth Osnes-Stoedefalke.

Funding acquisition: Maxwell Boykoff, Beth Osnes-Stoedefalke.

Investigation: Maxwell Boykoff, Beth Osnes-Stoedefalke.

Methodology: Maxwell Boykoff, Harsha Gangadharbatla.

Project administration: Maxwell Boykoff, Harsha Gangadharbatla.

Resources: Maxwell Boykoff.

Software: Harsha Gangadharbatla.

Supervision: Maxwell Boykoff, Beth Osnes-Stoedefalke.

Visualization: Maxwell Boykoff.

Writing – original draft: Maxwell Boykoff, Harsha Gangadharbatla, Beth Osnes-Stoedefalke.

Writing – review & editing: Maxwell Boykoff, Harsha Gangadharbatla, Beth Osnes-Stoedefalke.

References

1. Copernicus Climate Change Service. Global Climate Report 2024 confirms last year as the warmest on record, first ever above 1.5°C annual average temperature. 2025 [cited May 12, 2025]. Available from: https://www.copernicus.eu/en/news/news/copernicus-global-climate-report-2024-confirms-last-year-warmest-record-first-ever-above

2. NOAA. Global Monitoring Laboratory: Trends in Carbon Dioxide. 2024 [cited January 10, 2025]. Available from: https://gml.noaa.gov/ccgg/trends/monthly.html
3. NASA. Global temperature. 2025 [cited accessed May 12, 2025]. Available from https://climate.nasa.gov/vital-signs/global-temperature
4. IPCC. Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II, and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Lee H, Romero J, editors. IPCC; 2023. https://doi.org/10.59327/IPCC/AR6-9789291691647
5. Aronczyk M, Boykoff M, Coan T, Lahsen M, Morris H, Russill C. Chapter 6: Steering the discourse: legacy news, social media, advertising and public relations. In: Roberts JT, Milani C, Jacquet J, Downie C, editors. First Global Assessment of Climate Obstruction. Oxford: Oxford University Press; 2025.
6. Brulle RJ. Advocating inaction: a historical analysis of the Global Climate Coalition. Environ Politics. 2022;32(2):185–206. https://doi.org/10.1080/09644016.2022.2058815
7. Supran G, Oreskes N. Rhetoric and frame analysis of ExxonMobil's climate change communications. One Earth. 2021;4(5):696–719. https://doi.org/10.1016/j.oneear.2021.04.014
8. Hsu T. A PR giant is caught between climate pledges and fossil fuel clients. The New York Times. 2021 [cited accessed May 3, 2025]. Available from: https://www.nytimes.com/2021/12/10/business/media/a-p-r-giant-is-caught-between-climate-pledges-and-fossil-fuel-clients.html
9. Noor D. PR giant Edelman worked with Koch network, despite climate pledges. The Guardian. 2024 [cited May 4, 2025]. Available from: https://www.theguardian.com/us-news/2024/jan/14/edelman-charles-koch-foundation-climate
10. Boykoff MT. Climate change countermovements & adaptive strategies: insights from the Heartland Institute annual conferences a decade apart. Clim Change. 2024;177(5). https://doi.org/10.1007/s10584-023-03655-5
11. Barrett E. Edelman wins COP30, critics hit back. PR Week; 2025 [cited 2025 Aug 4]. Available from: https://www.prweek.com/article/1927512/edelman-wins-cop30-critics-hit-back
12. Brulle RJ, Aronczyk M, Carmichael J. Corporate promotion and climate change: an analysis of key variables affecting advertising spending by major oil corporations, 1986–2015. Clim Change. 2020;159:87–101.
13. Goldenberg S. Edelman formally declares it will not accept climate denial campaigns. The Guardian. 2014 [cited April 25, 2025]. Available from: https://www.theguardian.com/environment/2014/aug/07/edelman-pr-climate-change-denial-campaigns
14. Meyer C. Lululemon relying on fossil fuel-linked PR firm as it faces greenwashing allegations. The Narwhal. 2024 [cited May 5, 2025]. Available from: https://thenarwhal.ca/lululemon-greenwashing-allegations-edelman/
15. Farrell J. Corporate funding and ideological polarization about climate change. Proc Natl Acad Sci U S A. 2016;113(1):92–7. https://doi.org/10.1073/pnas.1509433112 PMID: 26598653
16. Benkler Y, Faris R, Roberts H. Network propaganda: manipulation, disinformation, and radicalization in American politics. Oxford: Oxford University Press; 2018.
17. Carvalho A. Media(ted)discourses and climate change: a focus on political subjectivity and (dis)engagement. WIREs Climate Change. 2010;1(2):172–9. https://doi.org/10.1002/wcc.13
18. Brulle RJ, Roberts JT. Climate Misinformation Campaigns and Public Sociology. Contexts. 2017;16(1):78–9. https://doi.org/10.1177/1536504217696081
19. Aronczyk M, Espinosa MI. A strategic nature: Public relations and the politics of American environmentalism. Oxford University Press; 2022. p. 320.
20. Westervelt A, Green M. How the media greenwashes the fossil fuel industry. The Nation. 2023 [cited March 12, 2025]. Available from: https://www.thenation.com/article/environment/media-greenwashing-climate-change/
21. Simula H, Lehtimäki T. Managing greenness in technology marketing. J System Info Tech. 2009;11(4):331–46. https://doi.org/10.1108/13287260911002486
22. Whelan H, Jordan TJ. Investors challenge 'blind spots' in climate-friendly ratings for ad and PR giants. 2024 [cited April 22, 2025]. Available from: https://www.desmog.com/2024/02/25/wpp-omnicom-esg-investing-climate-ratings-financial-risks-publicis-ipg-dentsu-fossil-fuel-clients-advertising-pr-agencies/
23. Vandenbergh MP, Miller J, Blair MM, Gilligan JM. The Moral Boundary of the Firm. Iowa Law Review, working paper number 24-44. 2025.
24. Hoffman AJ. Shades of green. Ross School of Business Paper. 2008 (1362):40–9.
25. Dunlap RE. Climate change skepticism and denial: an introduction. Am Behav Sci. 2013;57(6):691–8.
26. Carrington D. Revealed: oil sector's 'staggering' $3bn-a-day profits for last 50 years. The Guardian. 2022.
27. Yoo H. In global ad spend forecasts, CTV is poised to overtake linear. AdExchanger. 2023 [cited March 9, 2025]. Available from: https://www.adexchanger.com/online-advertising/in-global-ad-spend-forecasts-ctv-is-poised-to-overtake-linear/
28. Fischer S. Ad industry growing at record pace. Axios. 2021 [cited February 15, 2025]. Available from: https://www.axios.com/2021/12/07/advertising-industry-revenue
29. Angwin J. Trump moves to silence a new target. New York Times. 2025;A16.
30. Dimitriadis D, Grostern J, Bright S. How Shell Used a 'Granfluencer' to Promote Its Brand, DeSmog. 2023. Available from: https://www.desmog.com/2023/08/15/shellgranfluencer-promote-fossil-fuels-greenwash/

31. Rittenhouse L. US ad industry predicted to grow 5% in 2023 and get a political boost in 2024. Ad Age. 2023 [cited February 17, 2025]. Available from: https://adage.com/article/agency-news/us-ad-industry-grow-5-2023-43-2024-brian-wieser-predicts/2514506
32. Sheehan K, Morrison D. Advertising leadership and climate change: The efficacy of industry professionals to address climate issues. Advert Soc Quart. 2018;19(1).
33. Gangadharbatla H, Morrison D. A playbook for engaging in social and environmental activism in advertising. Advert Soc Quart. 2022;23(1). Available from: https://muse.jhu.edu/pub/21/article/853006
34. Lustick DS, Lohmeier J, Chen RF, Wilson R, Rabkin D, Thompson SR. ScienceToGo.org: The strengths and weaknesses of communicating climate change through mass transit advertising spaces. American Geophysical Union; 2016. ED33A-07.
35. Wilson RT, Lohmeier JH, Lustick DS, Chen RF. Using transit advertising to improve public engagement with social issues. Int J Advert. 2021;40(5):783–809.
36. Osnes B, Fahmy S. Keeping the fun in staying with the trouble: Green suits and environmental activist pleasure. Theatr Top. 2022;32(2):49–60.
37. Calder BJ, Malthouse EC. Media engagement and advertising effectiveness. Kellogg on Advertising & Media: The Kellogg School of Management; 2012. p. 1–36.
38. Huang M, Fang Z, Weibel R, Zhang T, Huang H. Dynamic optimization models for displaying outdoor advertisement at the right time and place. Int J Geogr Inf Sci. 2020;35(6):1179–204. https://doi.org/10.1080/13658816.2020.1823396
39. Boykoff M. Creative (climate) communications: productive pathways for science, policy, and society. Cambridge University Press; 2019.
40. Ehret PJ, Sparks AC, Sherman DK. Support for environmental protection: an integration of ideological-consistency and information-deficit models. Environ Politics. 2016;26(2):253–77. https://doi.org/10.1080/09644016.2016.1256960
41. Davies SR. Constructing communication: talking to scientists about talking to the public. Sci Commun. 2008;29(4):413–34.
42. Pavlou PA, Stewart DW. Measuring the effects and effectiveness of interactive advertising: A research agenda. J Interact Advert. 2000;1(1):61–77.
43. Sreejesh S, Paul J, Strong C, Pius J. Consumer response towards social media advertising: Effect of media interactivity, its conditions, and the underlying mechanism. Int J Inf Manage. 2020;54:102155.
44. Hochman N. From Site-specificity to Hyper-locality: Performances of Place in Social Media. In: The SAGE Handbook of Social Media Research Methods. SAGE Publications Ltd; 2016. p. 367–85. https://doi.org/10.4135/9781473983847.n22
45. Kerr G, Richards J. Redefining advertising in research and practice. Int J Advert. 2021;40(2):175–98.
46. Smith NW, Joffe H. Climate change in the British press: the role of the visual. J Risk Res. 2009;12(5):647–63. https://doi.org/10.1080/13669870802586512
47. Hansen A, Machin D. Visually branding the environment: climate change as a marketing opportunity. Discourse Stud. 2008;10(6):777–94. https://doi.org/10.1177/1461445608098200
48. Co2isgreen.org. More CO2 results in a greener earth: about us. 2010 [cited May 1, 2025]. Available from: http://co2isgreen.org/default.aspx/MenuItemID/138/MenuGroup/Home.htm
49. Eisend M, Tarrahi F. The Effectiveness of Advertising: A Meta-Meta-Analysis of Advertising Inputs and Outcomes. J Advert. 2016;45(4):519–31. https://doi.org/10.1080/00913367.2016.1185981
50. Lasswell HD. The structure and function of communication in society. 1948.
51. Lucas DB, Britt SH. Measuring advertising effectiveness. McGraw-Hill Book Company; 1963. p. xi, 399. https://doi.org/10.1037/13112-000
52. Decrop A. The influence of message format on the effectiveness of print advertisements for tourism destinations. Int J Advert. 2007;26(4):505–25. https://doi.org/10.1080/02650487.2007.11073030
53. Janssens W, Pelsmacker PD. Emotional or informative? Creative or boring? Int J Advert. 2005;24(3):373–94. https://doi.org/10.1080/02650487.2005.11072930
54. Martín-Santana JD, Reinares-Lara E, Muela-Molina C. Music in radio advertising: Effects on radio spokesperson credibility and advertising effectiveness. Psychol Music. 2015;43(6):763–78. https://doi.org/10.1177/0305735614567701
55. Riebe E, Dawes J. Recall of radio advertising in low and high advertising clutter formats. Int J Advert. 2006;25(1):71–86. https://doi.org/10.1080/02650487.2006.11072952
56. Sewall MA, Sarel D. Characteristics of Radio Commercials and Their Recall Effectiveness. J Mark. 1986;50(1):52–60. https://doi.org/10.1177/002224298605000105
57. Bellman S, Schweda A, Varan D. A Comparison of Three Interactive Television AD Formats. J Interact Advert. 2009;10(1):14–34. https://doi.org/10.1080/15252019.2009.10722160
58. Laskey HA, Fox RJ, Crask MR. Investigating the impact of executional style on television commercial effectiveness. J Advert Res. 1994;34(6):9–17.
59. Baltas G. Determinants of Internet Advertising Effectiveness: An Empirical Study. Int J Market Res. 2003;45(4):1–9. https://doi.org/10.1177/147078530304500403
60. Herrewijin L. The effectiveness of in-game advertising: the role of ad format, game context, and player involvement. ProQuest; 2015. Available from: https://www.proquest.com/docview/1695814456?pq-origsite=gscholar&fromopenview=true

61. Donthu N, Cherian J, Bhargava M. Factors influencing recall of outdoor advertising. J Advert Res. 1993;33(3):64–73.
62. Bhargava M, Donthu N, Caron R. Improving the effectiveness of outdoor advertising: lessons from a study of 282 campaigns. J Advert Res. 1994;34(2):46–56.
63. Prendergast G, Hang CC. The Effectiveness of Exterior Bus Advertising in Hong Kong. J Int Consum Market. 1999;11(3):33–50. https://doi.org/10.1300/j046v11n03_03
64. Wells W, Spence-Stone R, Moriarty S, Burnett J. Australian Advertising Principles and Practice. Pearson Education Australia; 2008.
65. Hu Z, Huang D, Wang S. Joint Optimization of Bus Scheduling and Targeted Bus Exterior Advertising. J Transp Eng, Part A: Systems. 2023;149(5). https://doi.org/10.1061/jtepbs.teeng-7812
66. Wilson RT. Out-of-Home Advertising: A Systematic Review and Research Agenda. J Advert. 2022;52(2):279–99. https://doi.org/10.1080/00913367.2022.2064378
67. Turley LW, Shannon JR. The impact and effectiveness of advertisements in a sports arena. Journal of Services Marketing. 2000;14(4):323–36.
68. Petty RE, Cacioppo JT. The elaboration likelihood model of persuasion. In: Berkowitz L, editor. Advances in Experimental Social Psychology. Vol. 24. San Diego (CA): Academic Press; 1991. p. 123–205.
69. Pilelienė L, Grigaliūnaite V. Elaboration of the model for the assessment of outdoor advertising effectiveness. J Emerg Trends Mark Manag. 2016 [cited 2025 Aug 8]. Available from: https://www.etimm.ase.ro/?p=85
70. Wilson RT. Out-of-Home Advertising: A Systematic Review and Research Agenda. J Advert. 2022;52(2):279–99. https://doi.org/10.1080/00913367.2022.2064378
71. Roux AT. Practitioners' view of the role of OOH advertising media in IMC campaigns. Management: Journal of Contemporary Management Issues. 2016;21(2):181–205.
72. Roux T, Lamprecht S. Exploring mini-bus taxi advertising effects based on the theory of hierarchy-of-effects: A South African commuter perspective. J Glob Bus Technol. 2022;18(2):86–99.
73. Išoraitė M, Gulevičiūtė G. Outdoor advertising effectiveness evaluation from customers' view. Entrepreneurship and Sustainability Issues. 2023;10(3):10
74. Center for Research on Environmental Decisions, ecoAmerica. Connecting on Climate: A Guide to Effective Climate Change Communication. 2014.
75. Ngo TK, Nguyen TH. The intention to use QR code payment in an emerging market–the role of "Attitude" as mediator. Psychol Educ J. 2021; 58(1): 3440-54.
76. Hernandez J. With a boost from John Oliver, Pūteketeke soars to first in New Zealand bird contest. NPR; 2023 [cited April 28, 2025]. Available from: https://www.npr.org/2023/11/15/1213228757/john-oliver-new-zealand-bird-century-contest-puteketeke
77. Forest & Bird. Bird of the century: Pūteketeke Pandemonium Prevails! 2024 [cited May 7, 2025]. Available from: https://www.birdoftheyear.org.nz/
78. Paul L. John Oliver-backed puking Pūteketeke wins New Zealand bird of the century poll. Rolling Stone. 2023.
79. Goldberg MH, Gustafson A, Rosenthal SA, Leiserowitz A. Shifting Republican views on climate change through targeted advertising. Nat Clim Chang. 2021;11(7):573–7.
80. O'Neill SJ, Smith N. Climate change and visual imagery. Wiley Interdiscip Rev Clim Chang. 2014;5(1):73–87.
81. Ungar S. Apples and oranges: probing the attitude-behaviour relationship for the environment. Can Rev Sociol Anthropol. 1994;31(3):288–304.
82. Ockwell D, Whitmarsh L, O'Neill S. Reorienting climate change communication for effective mitigation: forcing people to be green or fostering grass-roots engagement? Sci Commun. 2009;30(3):305–27.