Intriguing, Concerning, and Questioning the Impact on Immersion: An Exploration of VR Users' Advertising Experiences and Attitudes

Abraham Mhaidli
Max Planck Institue for Security and Privacy
Bochum, Germany
abraham.mhaidli@mpi-sp.org

Selin Erin Fidan
Max Planck Institute for Security and Privacy
Bochum, Germany
School of Information
University of Michigan
Ann Arbor, Michigan, USA
selin.fidan@mpi-sp.org

Florian Schaub
School of Information
University of Michigan
Ann Arbor, Michigan, USA
fschaub@umich.edu

Abstract

Many companies are experimenting with, and developing, advertisements for virtual reality (VR) consumer applications. So far, the development of VR advertising has not accounted for the voices of VR users. Since VR users will be the ones impacted by VR advertising, it is both a requirement and a moral imperative to center their voices in the discussion. We interviewed 22 VR users (14 of which had experienced VR ads, 8 of which had not) to understand their experiences with, and attitudes towards, VR advertising. Many participants had already encountered VR advertisements, ranging from static billboards in virtual worlds to virtual markets. While some participants acknowledged that VR advertising could provide benefits (including monetizing the VR ecosystem and more informative advertising), many were concerned about in-app VR advertisements ruining the immersion of VR experiences, unavoidable ads that were forced on users, privacy risks, physical harms, and manipulation. We conclude by discussing avenues for designing VR advertisements that align with users' needs and wants.

CCS Concepts

• **Human-centered computing** → *Virtual reality*; • **Security and privacy** → Social aspects of security and privacy;

Keywords

VR, VR Advertising, Manipulation, Immersion

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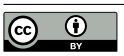

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1 Introduction

Researchers and marketers have long speculated on the emerging frontiers of the advertising ecosystem. Since the 1990s, researchers have created integrated marketing frameworks on the effectiveness of extended reality (XR) marketing [71] and consumer behavioral patterns [3] to engage consumers. As a result, increasing attention is being paid to virtual reality (VR) advertising possibilities. VR offers unique affordances that promise to make VR advertising *qualitatively different* from non-VR advertising. For example, the ability for VR to create fully digital worlds could allow realistic virtual recreations of products, supporting *experiential* and *sensory* advertising tactics that effectively shift consumers from passive observers to active participants [4, 7, 40]. As such, VR advertising allows consumers to interact with products virtually in ways previously not possible in non-VR advertisements [40, 56]. This shift to more direct interaction with ad content can lead to increased absorption and memory retention of the experience to build stronger consumer-brand relationships [10]. The flip side is that these factors that separate VR advertising from traditional advertising methods (i.e., print, television, radio, internet) can also introduce novel harms. We know from prior work that non-VR advertising poses consumer risks, ranging from inconvenience and irritation to malware and financial harm [69, 77]. Further work has argued that VR advertising not only replicates these existing harms but can intensify existing problems and introduce new ones, including ways to misuse collected data, target and deceive users [27, 28, 40], along with the possibility of inflicting physical and emotional harms [39].

The rise in investment and technological innovation in the field has increased the availability and popularity of consumer-ready VR headsets. Thus, many companies and providers of VR platforms have begun to experiment with VR advertising [26, 39, 52, 57]. The ramping up of VR ads has sparked vigorous discourse around the perceived benefits and harms that VR advertising may bring, what VR ads should look like, and whether VR ads should even exist [39, 40, 52].

However, amid these discussions, the perspectives of VR users are being overlooked. To our knowledge, no research has investigated actual VR consumers' perceptions and attitudes toward VR advertisements. Have VR users experienced VR advertising? If so, what have their experiences been like? What are their hopes and concerns regarding advertising in VR? Understanding VR users'

perspectives toward VR advertising is of the utmost importance and, we argue, a moral imperative. As explained above, VR advertising's novel affordances will introduce new ways for marketers to interact with and potentially harm users. Since VR users will be the group most impacted by VR advertising, it is important to center their voices in the discussion to create a sustainable, equitable, and fair VR advertising ecosystem that best aligns with VR users' needs and wants. It may take years before VR goes mainstream outside of gaming, enterprise, and medical products; however, considering that VR advertisements already exist within these domains, we should consider VR users as integral stakeholders in the developing advertising ecosystem. By understanding current VR users' experiences with and attitudes towards VR advertisements, we can better prioritize and effectively mitigate the potential harms emerging within the VR advertising space. Therefore, we argue that their experiences and attitudes should be at the forefront of the discussion.

To fill this gap, we conducted an exploratory study to understand the perspectives of VR users experiences with and toward VR advertising. More specifically, we conducted 22 semi-structured interviews with VR users (14 of which had experience with VR ads, 8 of which had not) to explore their experiences with VR advertising, their general attitudes towards advertising in VR, and their perceived benefits and concerns regarding the future of VR advertising. Our findings indicate that most participants had already encountered some form of VR advertising, ranging from static virtual billboards to fully realized VR markets where users could purchase products, and regarded these ads as novel and interesting – this suggests that VR advertising is already quite prevalent and is perceived as being both novel and different than advertising in other media (online, mobile, TV, print). However, participants were much more apprehensive when thinking about the future of VR advertising, highlighting worries about inescapable VR ads, VR ads blocking content, privacy risks, physical harms, and VR ads manipulating vulnerable users by leveraging the immersion and 'fun' factor of VR to make dangerous products seem irresistible. One key dimension of concern was immersion. Participants were worried about how VR ads could ruin the immersiveness of the VR experience; however, this was a nuanced case since some participants thought VR ads could enhance an experience's immersion (e.g., in VR applications that emulate real-world places, having ads that would ostensibly be found in that real-world place).

These findings increase our understanding of how VR users perceive the growth of advertising in their technological space, with much-needed insights into ways to address user concerns with regard to VR advertising. Specifically, the contributions of our study are as follows:

- We provide insights into how VR users experience VR ads 'in the wild,' finding that VR users are exposed to VR ads. These ads take various forms ranging from static billboards to fully fledged virtual worlds and markets, and users found these ads to be curious and intriguing.
- We highlight new worries that VR users have about VR advertising, including concerns about the physical harms of VR ads, that need to be considered when designing VR ads.
- We provide insights into the importance and nuanced role of immersion within VR advertising. Beyond simply ads ruining immersion, our findings show how ads could enhance immersion in the right circumstances, and we underscore the important need for contextually-aware advertising in VR. Similarly, immersion should be considered when designing ad-blocking solutions. Ad-blocking solutions should seek to eliminate the ad and preserve the immersion that would have otherwise been lost.

Through our contributions, we hope that stakeholders working in the space (including those designing VR experiences, VR advertisers, VR providers, researchers investigating VR ads, consumer advocacy groups, and those designing VR ad-blocking solutions) can consider these lessons and design a VR advertising space that respects users' needs and wants.

The remainder of this paper is structured as follows. We start with background information on the current state of VR advertising and its harms. We then examine related work on how people view advertising, particularly in non-VR contexts. We then describe our method in detail, followed by our findings. We conclude by discussing the significance of our findings.

2 Background on VR Advertising and Consumer Attitudes

2.1 VR Advertising

VR is a broad term that encompasses technologies that substitute reality with a completely virtual and digital world, such as through digital graphics [37]. In today's day and age, the most mainstream consumer-grade VR technology is the VR headset, such as the Meta Quest 3, the Apple Vision Pro, or the Pico 4; these are apparatuses that users wear on their heads to see a completely virtual world [40].

VR advertising is any advertising that takes place in that medium. Advertising is also a broad term with many different definitions, but all have in common the idea of a message being used to promote the sale of a product (e.g., see Nicosia [45] and Richards & Curran [50]). For this paper, we define VR advertising as any VR experience or component of a VR experience that attempts to promote a product or convince users to buy a product. Ostensibly- anything in VR that promotes a product could be considered an advertisement, including 2-D videos, 360 videos, 3-D avatars, or banner ads in VR [73].

Current state of VR advertising. Currently, VR advertising is relatively limited in scope. To our knowledge, VR advertising is not yet a mainstream monetization choice for VR apps, and there have been no reports of major advertising campaigns in VR. With that being said, VR ads do exist. Mhaidli et al. [39] discovered over 87 standalone VR marketing experiences across the Steam and Oculus VR app storefronts. Similarly, a multitude of organizations within the VR ecosystem have spoken publicly about plans to experiment with or create VR ads, including Meta [25], Sephora [52], and more [52]. Furthermore, there are also startups exploring this space, established corporations with VR divisions, and funds investing in VR companies [74]. Overall, this suggests that VR advertising is in a state of flux, with experimentation, rapid development, and constant change.

How is VR different from non-VR advertising? While there is a lot of overlap between VR and non-VR advertising, scholars have posited that there will be three key differences between VR and non-VR advertising once VR advertising is more established and mainstream [36, 40, 64]. The first is immersion. Immersion refers to "a psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences" [72]. In the context of VR technologies, scholars have highlighted how VR provides a more immersive experience than other technologies, such as smartphones or TV. This experience is mainly achieved by the affordances VR offers, including isolation from the physical environment and a responsive environment that reacts to users' inputs [72]. For example, many VR headsets offer 360° field of vision (as opposed to a computer or TV screen, which involve flat images on a 2D screen). This occlusion, i.e., the blocking out of images of the 'real' world, aids immersion since people forget about the outside environment and thus the artificiality of the environment they are in and can fully focus on the VR environment in front of them [72]. Thus, the argument is that, since VR as an environment is more immersive, VR ads will also be more immersive: rather than simply watching an ad, VR users could feel absorbed in the ad they are seeing [40].

The second difference is that VR ads can be more interactive. Interactivity refers to the ability of an environment to respond to a user's inputs – the more responsive an environment is, and the more inputs it can respond to, the greater the interactivity of that environment [36]. VR environments are much more interactive compared to non-VR environments such as computers, smartphones, or TV screens. Non-VR environments are often limited to inputs in the form of mouse or touch interactions, While there are examples of non-VR advertising that could be classified as interactive (e.g., advergames), VR would allow for exponentially higher scale and degree of interactivity, both in terms of frequency (it is expected that most VR ads will be interactive in some way or form, as opposed to a minority of non-VR advertisements [40]), as well as the type of interactions supported (VR ads could allow users to use their arms and hands to pick up items in their environment, which would be much more interactive than moving a mouse cursor or tapping the screen [36]). Together, immersion and interactivity lead to an increased sense of presence. "Presence" is a subjective perception in which, at some level, individuals overlook the technological role of the generated experience [36]. The sense of presence experienced in VR is a crucial factor that makes VR successful at eliciting users' novel reactions.

The final difference between VR and non-VR advertising is that VR will allow for unprecedented ways to preview products, moving beyond static images and videos into more photorealistic virtual displays [40]. In a virtual world, for example, items can be scaled to real size, and users can pick up the items, rotate them, and examine them from all angles.

Potential harms of VR advertising. Scholars have identified numerous ways VR advertising could be harmful. These include VR ads showing graphic and disturbing content (i.e., shockvertising) [39]; physical harms (nausea, motion sickness, or chasing into walls) [1, 31, 39, 54]; manipulation [40] and mental harms, such as addiction and distress [6, 9, 46, 58].

Perhaps the most studied harm of VR advertising is privacy risks. The increased sensing capabilities of VR systems means VR ads could ostensibly capture sensitive information from a user, including biometric data, health data, and information about their surroundings [5, 12, 14, 30, 42, 43, 65]. While non-VR advertising also poses substantial privacy risks, the scope and magnitude of the data collection in VR exponentially increases the amount of data being collected, the inferences that can be made about users, and as such, the ensuing privacy risks and harms [40]. Privacy risks also feed into how ads could be used to manipulate users: Heller coined the term biometric psychography to describe how, through the collection of behavioral and physiological data, a VR advertisement can learn about VR users' psychological states (e.g., likes and dislikes) [27], which advertisers could use to target users' emotional vulnerabilities [28].

Another potential harm is deception. Deceptive design tactics, also known as manipulative design techniques and/or dark patterns, refer to interface design choices that distort a user's decision-making capabilities or deceive users into a certain action (e.g., users give up unnecessary personal information or cause cognitive burden to keep them engaged longer) [22]. Research points to two characteristics of VR that may raise unique risks: VR's experience capabilities (i.e., immersion and interactivity) and the extensive data collection needed to enable such an experience. Research suggests that the experience and data collection associated with VR technology may exacerbate existing dark patterns and open the door for new forms not present in other digital environments to develop, such as psychological manipulation, reality distortion, and tricking users' perceptions [23, 33]. For example, it has been theorized that, based on previously collected data, a VR advertisement may manipulate a user into a purchase decision by using immersion to hyper-personalize an advertisement targeted at the user's vulnerabilities [27, 40]. Furthermore, emerging technologies such as AI and neurotechnologies may be used in tandem with VR advertising to create even more powerful deceptive design tactics [59]. Although there has been a steady increase in research exploring the potential manipulative design elements of extended reality environments [8, 16, 23, 24, 33, 67], there has been less work researching dark patterns in VR advertising [13, 32].

2.2 Consumer Attitudes Toward Advertising

While consumer attitudes towards advertising tend to be negative, there are also positive perspectives on advertising. So far, not much research has investigated attitudes towards VR advertising.

Non-VR Advertising. Consumers generally hold negative views towards advertising in non-VR contexts [77]. Key consumer concerns are manipulation [63], irritation [49], the promotion of inappropriate topics [2], the use of disturbing and embarrassing images (e.g., ads with suggestive content) [2], and not trusting advertisers [55, 76, 77]. In the case of targeted advertising, there are privacy concerns over how consumer data is collected and used [63].

Having said that, consumers positively view and appreciate some features of advertisements. Consumers like the relevance and convenience of targeted ads [20, 78]. Consumers also appreciate interactive ads [75]. Looking beyond individual advertisements, some studies indicate that as an *institution*, advertising is generally seen as positive [48, 63]. Notably, consumers value the role that advertising plays in the economy, allowing consumers to learn about products and services available [48]. In the case of the internet, consumers mention that advertisements allow popular internet services to be free of charge [63]. Thus, we see that consumers hold nuanced views towards advertising.

VR Advertising. There has been less research on attitudes towards VR advertising. Burton and Schlieman [11] looked at comments on 360° video advertisements to gauge consumer attitudes. They find that users appreciate the novelty of the format and the feeling of presence VR advertising offers; however, there are complaints over technical issues (e.g., lag, lack of intuitive controls) limiting the experience. In looking at VR marketing in sports, Kunz and Santomier find that consumers look forward to VR as a way to allow for 'fun' interactions [34]. These imply mixed to positive views regarding VR advertising. However, these studies are limited in scope (e.g., examining attitudes towards one specific type of VR ad). A broader understanding of how VR users view VR ads is still required.

Our study fills this gap by asking and answering the following research questions:

(1) What are VR user's experiences with VR advertising?
(2) What are VR users' attitudes towards current and future VR advertisements?

Through this work, we contribute insights into how users perceive VR ads and what VR users consider to be concerning and harmful about VR advertisements.

3 Method

To gauge VR users' perceptions of VR advertisements, we conducted 22 semi-structured interviews to understand their experiences with and attitudes toward VR advertising.

Given the nature of our study, we chose to conduct exploratory interviews. More specifically, we wanted to allow space for participants to fully express their ideas and thoughts since VR advertising is still fairly novel and not yet well-understood. Exploratory interviews allowed us to gain deep, rich insights into VR users' attitudes toward VR advertisements to address this research gap. The interview process consisted of two key sections: probing participants experiences with existing VR ads, and exploring participants' perceived benefits and concerns about the future of VR ads.

Our institutions' Institutional Review Board (IRB) reviewed and deemed our study exempt from oversight.

3.1 Interview Logistics

We recruited participants through prominent VR subreddits (including Vive_VR, VRChat, OculusQuest2, OculusGo, Oculus, HoloLens, WindowsMR, LearnXR, WebXR, and WebVR) to reliably recruit participants with VR experience.

Gender		Age		Country	
Man	16	18-24	7	USA	12
Woman	3	25-34	10	Canada	4
Non-binary	2	35-44	2	Denmark	1
Transfem	1	45+	3	Italy	1
				Netherlands	1
				Portugal	1
				Scotland	1
				United Kingdom	1

Table 1: Participants' demographic information, including gender, age, and country.

Participants completed a screening survey about their general VR experience, specific experiences with VR ads, and attitudes toward advertising. We measured attitudes towards advertising using Petrovici and Marinov's advertising attitude scale [47]. We excluded participants who had not used VR. We recruited only VR users for our study because we were interested in their current experiences with VR ads, and because their experience with VR technologies means they can better imagine advertising in that medium and possible concerns within.

Furthermore, we stratified participants based on their attitudes toward advertising scale responses to ensure a mixture of opinions in the sample (positive, negative, and neutral). Following Zeng et al. [77], we asked whether the participants used an ad blocker and whether they liked seeing ads online. This helped further contextualize participants' attitudes towards advertising and provided data points we could ask about in the interview. We also collected participants' demographic information borrowing from Hughes et al [29]. The screening survey can be found in Appendix A.

Recruitment stopped once we achieved data saturation (i.e., when we did not hear any new themes or topics brought up in our interviews) [41, 53]. The interviews were conducted remotely via Zoom. Interviews lasted 65–103 minutes (median: 85min, average: 84min). Participants were compensated $40 for their participation.

3.2 Participant Demographics and VR Usage

We recruited 22 participants in total. Table 1 contains participant demographics, Table 2 contains information about participants' VR usage, and Table 3 contains information about participants' attitudes towards advertising and experience with VR ads.

Our sample skewed young and male: 16 participants identified as men, and 17 participants were aged 18-35. However, this reflects current VR usage statistics, which also skews towards young and male users [60–62]. Our participants had all used VR: most (18) had over three years of experience using VR, and over half (16) used VR weekly or daily.

While most of our participants (14) had already encountered VR ads, eight indicated they had not. Despite the fact that these latter participants could not meaningfully contribute to our first research question (experiences with existing VR ads), pilot testing showed that these users provided useful insights into the second research question asking about attitudes towards advertising in VR, as well as expressing hopes and concerns regarding the future of

Frequency		Time using VR		Reason		Headset	
Daily	6	> 5 years	8	Gaming	22	Oc. Quest	17
Weekly	10	3-5 years	10	Social VR	14	HTC Vive	11
Monthly	5	1-3 years	2	Watching videos	13	Oc. Rift	10
<Monthly	1	6-12 mo.	2	Fitness / well-being	11	Index	7
				Education	5	S.O. Plus	4
				Work	3	Oc. DK12	1
				Content Creation	2	Oc. Go	1
				Art	1	Lenovo Explorer	1

Table 2: Participants' VR usage, including how often they used VR, how long they have used VR, the reasons for using VR, and what headsets they used (Oc. is short for Oculus; Index refers to the Valve Index; S.O.Plus is the Samsung Odyssey Plus.

ID	Seen ads	Ad attitude	ID	Seen ads	Ad attitude
P1	Yes	13	P12	No	23
P2	Yes	33	P13	Unsure	25
P3	Yes	45	P14	Yes	32
P4	Yes	41	P15	No	42
P5	No	26	P16	No	39
P6	Yes	37	P17	No	39
P7	Yes	49	P18	Yes	30
P8	Yes	25	P19	Yes	26
P9	No	30	P20	Unsure	19
P10	Yes	29	P21	Yes	47
P11	Yes	33	P22	Yes	42

Table 3: Participants' VR usage statistics. The *Seen ads* column indicates whether participants had seen VR ads prior to participating in the study. The *Ad attitudes* column was the score we calculated in the screening survey to determine the participant's attitude towards advertising. Higher scores indicate more negative attitudes towards advertising. Possible scores participants could have gotten ranged from 7 to 49.

advertising in VR. Thus, we chose not to exclude these participants from our study.

Lastly, participants varied greatly in terms of their attitudes towards advertising. To calculate attitudes towards advertising, we used Likert items taken from Petrovici and Marinov that asked participants to rate advertising on a 7-point scale on measures such as good/bad, useful/useless, and necessary/unnecessary [47]. We then computed a sum of the Likert items as a heuristic measure of attitudes toward advertising, with higher scores indicating more negative views towards advertising. For these scores, participants could have obtained a minimum score of 7 (indicating positive approval for ads across the board) or a maximum of 49 (everything rated as negatively as possible). In our sample, participant scores ranged from 13 to 49. two participants had scores under 20 (suggesting positive views regarding advertising); five participants had a score between 21 and 27 (neutral to positive); six participants had a score between 28 and 34 (neutral to negative); and nine participants had a score greater than 35, with five participants having a score higher than 42 (negative). While our participant sample skewed slightly towards negative views regarding advertising, we recruited participants such that positive, negative, and neutral attitudes regarding advertising were represented in our sample.

3.3 Interview Protocol

We started each interview by asking participants about their general thoughts regarding advertising. This was done to ease participants into the interview and help them become comfortable talking to the interviewer. Next, we asked about their VR usage and whether they had encountered VR advertisements; if so, we probed about their experiences, attitudes, and reactions toward these ads. Finally, we asked about what hopes and concerns participants had regarding VR ads, including perceived and desired benefits and drawbacks and concerns. To help with this exercise, we asked the participants to envision a world in which VR usage, and by extension, VR advertising, was more established and mainstream than today. We asked them to elaborate on this world and then asked specific questions about what VR advertising might look like and what they perceived as benefits and concerns. When asking about users' attitudes toward VR advertising, we wanted to take a broad, future-oriented approach. Current examples of VR advertising may be a poor heuristic of the types of VR ads that will be seen 5 or 10 years from now. As such, rather than focusing on a specific instantiation of VR ads, we deliberately allowed our participants to think broadly about what the future could hold and then gauge their attitudes and concerns.

The full interview script is available in Appendix B.[1]

3.4 Interview Analysis

We analyzed the interviews using thematic analysis [66]. The first two authors iteratively generated an initial version of the codebook using a set of deductive codes [41] derived from the literature. The codebook was then refined through inductive coding as follows. The two first authors independently used the codebook to analyze one randomly selected interview transcript: they then came together to discuss areas of disagreement and parts of the transcript that were relevant to the research questions but not captured by the current codebook. The codebook was modified accordingly, and the authors proceeded to the following interview. This proceeded until all aspects of the interviews relevant to our research questions were represented in our codebook. This took 12 iterations. Once the codebook was finalized, the lead author then re-coded all interviews with the final version of the codebook. This combination of deductive and inductive coding allowed us to focus on consumer attitudes towards VR advertising while maintaining the flexibility to adapt and capture additional themes, such as specific attitudes

[1]This interview was part of a larger, two-part interview. In the second part, we asked additional questions regarding participants' reactions to specific fictional examples of VR advertisements that displayed manipulative techniques. The data we obtained from the interviews was too rich and detailed to cover properly in one paper. Since the additional questions about participants' reactions to VR manipulative techniques happened in the second part of the interview, we excluded those from this paper, focusing here on participants' experiences and attitudes regarding VR advertising at large. Findings specific to participants' reactions toward the specific fictional VR advertisements will be reported in future work.

we may not have predicted or foreseen (e.g., particular benefits of VR advertising). Given the context of this study (codes are not the main output of the study, and the lead author is an expert in both qualitative methods and the topic being studied, which is VR advertising), single-author analysis was deemed sufficient to generate useful, reliable insights into the data [38]. The codebook can be found in Appendix C.

4 Findings

Many of our participants had already been exposed to VR ads. Regarding attitudes towards VR advertising, we found participants were often wary and skeptical, highlighting worries about ads breaking the immersion and ruining the VR user experience, privacy concerns, and physical harm. However, views were more nuanced than 'VR ads equals bad'—participants also saw advantages of VR advertising, such as better previewing products and helping monetize the VR ecosystem. Next, we discuss participants' experiences and attitudes in more detail.

4.1 Participants' experiences with VR advertisements

Our first research question asked about users' experiences with VR advertising. Over half of our participants (14) reported having seen VR advertisements; however, they were rare experiences in which participants would encounter VR ads very infrequently, rather than in every single VR experience they engaged with.

The most primitive type of ads participants reported were banner ads in VR app menus, e.g., a banner ad for a game expansion pack or sequel. For some participants, these types of ads were annoying, such as P6, who claimed VR ads did not provide much value and were just *"an extra step"* they had to go through before being able to access the content they wanted to access. Others, though, expected to find these kinds of banner ads and so did not see these ads as a huge issue.

Another type of VR ad a few participants encountered was not through VR headsets but rather through set promotional exhibits outside their homes. These were standalone experiences at specific locations (e.g., storefronts, movie theatres, etc.) that promoted a certain product. P5 described encountering a VR exhibit for Game of Thrones:

> *"It's like you're going up the [wall] [...] And then once you get up there, it's like they're the people in the north were shooting fire arrows at you. So that was my first experience with VR, which I thought was quite cool."*

Similarly, P16 remembered seeing various of these types of advertisements:

> *"I remember I was at New York ComicCon one year and he had something for Dwayne Johnson movie Skyscraper, balancing on a beam with a headset. So yeah, some stuff is for movies or other video games. We had a little Halo promotional thing, I think it's called Recruit."*

Figure 1 shows a screenshot of this Skyscraper experience. Participants who had encountered these ads thought they were interesting experiences but would not be interested in experiencing them again.

Advertising in Social VR. Participants also encountered advertisements in social VR (e.g., VRChat, AltSpace VR). These apps often feature individual worlds users can visit. Participants mentioned that some of these worlds have posters or billboards advertising products. Participants were generally OK with this practice since these posters helped support the VR world's creators. For example, P21 described:

> *"in VRChat they often have banners and posters inside their world saying, oh you can go to my Patreon[2] and you can get extra stuff that I don't mind them too much because they are directly towards that experience that I'm already in."*

However, a few participants complained that these ads were too obtrusive, such as P22, who described these posters as *"stick[ing] out like a sore thumb. [It] feels like it shouldn't be there."*

Participants also reported a form of advertising in social VR that they perceived to be more negative: virtual users shouting at passersby about products they are selling. In P20's specific case, it was about cryptocurrencies and NFTs.

> *"There's definitely a lot more of people like in VR chat, screaming out 'Buy crypto!' I'm like, yeah, I'm not going to listen to you, dude. Or even the NFTs. I'm like, yep, definitely not going to listen to you too."*

Such experiences were not only annoying, but P20 thought, could be potentially dangerous, given that these sellers could be scammers. Neither we nor P20 could confirm whether the virtual sellers promoting NFTs and cryptocurrencies were scammers or legitimate sellers. Still, given the prevalence of scams concerning cryptocurrencies [44], it seems possible that some malicious actors could be using this tactic to promote cryptocurrency (or other) scams, whether in this instance with P20 or in others.

Virtual Avatar Ads. Participants had also encountered ads attached to virtual avatars. Some creators append a label, plaque, or even a QR code to virtual avatars and assets they create. This meant that VR users interested in an avatar or asset they saw could scan the QR code in VR to learn more about the creator or purchase models. Per P20:

> *"If you click on an avatar, it'll say 'made by this person', and you can always read the details of your avatar that's on there and it'll say, 'hey, if you want this, go on Discord and we can work out something.'"*

VR Marketplace. The most elaborate VR advertising participants encountered was a VR market — a biannual event held in VRChat where users could walk around a virtual market. Companies would set up booths where users could examine, explore, and purchase products, including both virtual products (e.g., VR avatars) and physical ones (e.g., Manga comics, energy drinks, food delivery services, and cars). Figure 2 shows a screenshot of a stall at this

[2]Patreon https://www.patreon.com/ is an online platform where users pay monthly subscription fees to creators.

Figure 1: A screenshot of a VRad promoting the movie "The Skyscraper", which one of our participants experienced. This screenshot was taken from a YouTube video showing the experience, found at https://www.youtube.com/watch?v=yA8QLDkzf78.

Figure 2: A Gamersupps stall (a company selling energy drinks) in the summer 2022 virtual market. Image obtained from https://summer2022.vket.com/en/company/25, a website showing highlights from the Summer 2022 virtual market, which a few of our participants attended.

virtual market. Participants who had experienced the VR market spoke positively of the experience, describing it as a fun event they were looking forward to. For example, P1 mentioned that:

> *"A lot of people go visit [the market] on purpose. They have a night where they'll go with their friends and they'll tour around the virtual market and kind of interact with every single booth."*

All participants who had encountered VR ads noted that they were still rare. Furthermore, these ads were often not perceived as intrusive and were, for the most part, optional ads in the sense that one could choose whether or not to engage with them.

4.1.1 Engage with VR ads as an experience, not an ad. Participants' experiences with VR ads ranged from slight annoyance to looking forward to and even seeking out VR advertising experiences. Aside from learning more about the advertising types that VR users are encountering, one interesting takeaway from these findings is how many VR users treat these as fun experiences rather than ads. This

is reflected in how few participants reported shopping from these ads. Participants who visited the virtual markets sometimes stopped to see a poster in VR, but only one participant (P21) reported purchasing an item based on an ad in VR. In their case, they purchased a virtual avatar after seeing a plaque promoting it in a virtual world. This action implies that participants who enjoyed seeing ads did not enjoy them for their function as ads but due to their function as a fun VR experience that just happened to advertise a product.

4.2 Perceived Benefits of VR advertising

Our second research question asked about VR users' attitudes toward VR advertisements. While the first research question focused on VR ads as they exist today, this second one was more future-oriented, asking about attitudes toward what advertising could be like in VR. Our participants were generally wary and apprehensive about the future of advertising in VR. However, views were nuanced, with several participants acknowledging some potential benefits. In this section, we discuss participants' positive and general attitudes; we then report concerns in Section 4.3.

VR ads might be useful and informative. When thinking about the future of VR advertising, participants thought VR ads could be more useful and more informative than non-VR advertising, given the ability to better see and interact with products in VR. For example, P19 said

> *"You could just get a much better feel for whatever you're being advertised. So again, the 3D products, stuff like that is a much better representation than just a few pictures online."*

P5 felt VR could help in choosing vacation destinations:

> *"Sometimes when you're comparing prices of Airbnbs or hotels or whatever online you see something much cheaper. And if you look at Google map, oh it's only about a 10-minute walk from the more expensive place. But sometimes that 10-minute walk can lead you to a whole different area of the place that you might not want to be in. [...] with a VR headset, I could use that to determine if paying the extra money for that whole hotel is worth it."*

Participants anticipated that through VR, it would be possible to get more information about what a product is like than through non-VR advertising.

Convenience of shopping from home. Another potential benefit participants saw of VR advertising, and virtual shopping more broadly, were the perceived advantages of having high fidelity, accurate representations of products alongside the convenience of shopping from home.

> *"I'm a tall person and so if they accurately represent the scale of something, then I wouldn't need to physically go to a car dealership to find out if a vehicle is too big or small. For me, I'd just be able to sit in it in VR and say 'Hey, my height is this, how am I going to fit in this vehicle? What's the perspective I'm going to get?'"* (P15).

Similarly, P12 said:

> *"I'm definitely a homebody, spend much more time in VR than I do physically going places. I would find it so enjoyable to be able to go through clothing stores and check stuff out without physically going there and really getting the sense that you're properly seeing the product."*

For many participants, VR could combine the best of both online and in-person shopping: getting a better sense of what a product is like from the comfort of one's home.

VR ads might be more fun. Participants expressed that VR could allow for fun, cool, exciting, and interesting advertisements. First, VR and potential VR ads were seen as more interactive than non-VR ads, allowing for interaction techniques that could make advertising novel and fun. This was true for both current VR ads participants had encountered, but also for what the future of VR advertising has in store. For example, P6 highlighted how *"It's kind of cool sometimes just to interact and do something you don't do in the real world."* P8 highlighted the possibility of gamification in VR advertising: "*I think if it's made as a game, I could see myself or others being excited to try it out and [...] play together.*"

A second factor contributing to this was the novelty of VR as a medium. By being new and different, VR ads were seen as offering unique experiences that broke the monotony of non-VR advertising. P12 talked about their experience showing VR ads to friends:

> *"Anytime that I've brought new VR users to [VR advertisements] it's always a really high novelty experience for them and they always are quick to engage with picking up all of the products. So I think when it's done well, it really, it's a fun little thing."*

However, participants also expected this novelty to wear off eventually. Per P14:

> *"I think that's cool, but I think that will also fade in a couple years when VR advertising becomes mainstream. It's like, okay, it's just another ad."*

As such, the notion that VR ads might be fun should be taken with a grain of salt, since it is unclear if VR ads are inherently more enjoyable than non-VR advertising or just novel.

Monetize the VR space and raise it to new heights. The next theme we observed was how advertising could monetize the VR space. Some participants appreciated (and looked forward to) VR advertisements providing revenue sources for VR content creators. Participants thought ads could fairly reward creators and incentivize the creation of higher quality VR experiences:

> *"VR is still small, it's mostly small indie developers that are [creating experiences]. I feel [advertising] could be a very good way for them to make a little bit of extra money to be able to produce even more awesome experiences"* (P13).

Others also noted that VR ads could help subsidize costs for consumers. P5, for example, was skeptical of advertising in VR; however, they mentioned that they would be open to trying VR ads if they lowered costs for consumers:

> *"if [VR advertising] brings down the prices potentially, I mean I'm indifferent. That one I could get behind it. I*

wouldn't say I'll be like 'yay, let's do it'. I'll be like 'OK, let's try it out and see.'"

As such, VR advertising was seen as a force that could help improve the VR ecosystem.

4.3 Concerns Regarding VR Advertising

While exploring users' attitudes, many participants expressed concerns regarding VR advertising, such as content access limitation, breaking the immersive VR environment, privacy risks, and the potential of physical harms.

Blocking or limiting access to content. One key concern was how VR advertising could be used to block or limit access to content (e.g., VR users being forced to experience a VR ad before loading content). Furthermore, participants felt that the mere presence of VR ads could be distracting. Participants were worried about ads being *"in your face"* (P6, P7, P11, P14, P18, P19), *"obtrusive"* (P11, P16, P21, P22), and *"intrusive"* (P7, P10, P18, P19), with some users worrying about an *"ad bombardment"* (P1, P6, P17, P18 P19). For P2, this was a major concern for advertising in VR:

"If they [Meta] can get away with it, they'll be all in your face about it and they'll shove it down your throat if they can."

While ads blocking content is not unique to VR, many participants thought that VR could make such blocking worse. Factors that contributed to this perception were the eye tracking capabilities of VR headsets (that could measure whether a user has engaged with an ad) and how VR headsets fix screens directly in front of users' eyes. For example, P14 thought that:

"The dystopian vision of VR advertising is an ad that gets stuck to your face and your pupils have to focus on the ad for 30 seconds before you can skip it."

P7 commented on how the VR screens automatically increased the instrusiveness of an ad:

"If you look at [an ad's] intrusiveness on a scale of 1 to 10 on a normal flat screen. If it's a 1 and it's not very intrusive at all, on a VR headset, it's a 3. If it's a 10 on a flat screen, it's a 13 [in VR]."

In-app VR ads could break (or make) immersion of VR. According to our participants, one of the appeals of VR technologies is the ability of VR to create highly immersive virtual worlds. Participants were worried about the effects of VR advertising, particularly in-app VR advertisements, on immersion. Per P15:

"[VR] works best when it is an immersive experience. And so if you have [an ad] that pulls you out of that experience [...] that's going to be detrimental to the user's experience"

Specifically, participants were worried that ads could remind users of the real world: *"If you're just doing something unrealistic, you don't want to actually be reminded of the real world"* (P17). This was seen as particularly problematic when the product being advertised had little to do with the current VR environment:

" [In VR] I feel like I'm sitting in a cockpit of a spaceship rather than my desk chair, and once you start saying, 'Oh also by Clorox', then the immersion's sort of broken" (P16).[3]

Having said that, participants also thought VR ads could enhance the realism and immersion of certain experiences, particularly those that aim to replicate real-world locations. P21 brought this up with regard to visiting New York in VR:

"We have adverts in the real world, they're placed all over in the environment. If you mimic that in VR, it almost makes it more realistic in a way because seeing Times Square without adverts would be more jarring, so having real adverts there would kind of integrate the experience more."

A similar sentiment was echoed by P13: *"I'm in a real place. This is a real restaurant I can go to in real life. So that might add to the immersion."* As such, if a VR experience is meant to replicate or imitate the real world, seeing ads for real products, as would be the case in the real world, could contribute positively to the experience.

In fact, seeing actual products being advertised was sometimes better than seeing fake products being advertised, which could be jarring and break the illusion of realism. This is a sentiment P18 felt strongly about. On discussing the possibility of having billboards in a VR racing game, P18 said:

"I'm firmly the camp of, yeah, that adds realism. Instead of seeing say, I don't know, LogiCola with a pink background, no, just make a Coca-Cola sign. It's what we have in the real world."

Participants were particularly worried about obvious, intrusive ads breaking the immersion of VR experiences, and many stated they would much prefer subtle ads, such as product placement, that were deeply embedded in the world and did not stand out. For instance, P17 said *"As long as I can't explicitly actually notice [the ad], then I'm fine with that."*

Distrust advertisers. At the same time, participants expressed distrust regarding VR advertisers and whether they would act in users' best interests when creating VR ads. P13 worried about VR advertisers taking ads *"too far"* in pursuit of money. Similarly, P7 said:

"Companies just don't have their users' best intentions at heart and will do whatever they can to make sure that you buy their product."

Particular hostility was held for Meta and its CEO, Mark Zuckerberg. Participants mentioned Meta's prior behaviors (such as the Cambridge Analytica scandal or their data collection practices) as proof that Meta could not be trusted. A few participants complained about Meta's *"walled garden"* approach (P17) to the VR ecosystem and would prefer a more open approach that is adaptable to the VR community's needs. P16 even described a particularly dystopian VR advertising landscape as the *"'Zuckerberg Wins' scenario."*

Participants also questioned whether Meta could produce high-quality VR advertisements, due to a perceived lack of quality in Meta's current VR experiences. P1 noted:

[3]Clorox is a company that produces disinfectant products, and to our knowledge, has little to do with space travel or being on a spaceship.

> *"I've been on [Horizons]. [...] when [Zuckerberg] posted the picture of him standing next to the Eiffel tower [...] I was like, I could have made that in five minutes. [...] I don't know how they're spending so much money and that is what they're coming up with."*

This distrust towards VR advertisers heavily impacted participants' perceptions of VR advertising risks. When discussing concerns about VR advertising, it isn't only a question of how VR advertisements could harm consumers: some participants believed that companies would actively pursue detrimental and potentially harmful practices to maximize profits.

Privacy concerns. Several participants expressed concerns about VR advertisements invading their privacy. VR ads were perceived as having more data collection capabilities than non-VR ads, and so participants were worried about what data could be collected and how it would be used. Particular worries were placed on eye-tracking data, and how this could be leveraged by advertisers to force attention on an ad. Other data participants were worried about included collecting physiological data (e.g., heart rate) and information about a user's environment, such as the layout of their home.

A few participants were not too concerned about their physiological data being used to personalize ads in the moment, but rather worried about how their data might be collected and used for other purposes:

> *"If I give permission for them to check my information, my heart rate, what I'm interested in, how do I know that information is not going to go out there and influence every single other aspect of my life online? And I don't think you can have that guarantee."* (P2).

Physical harms. A few participants worried about physical harm from VR ads, such as overstimulation, loud noise, motion sickness, flashing lights triggering seizures, and discomfort (e.g., the headset getting very hot).

Participants mentioned physical harm was a problem of VR more broadly but pointed out unique challenges VR ads presented. One concern was the effects of rough transitions between the regular VR experience and a VR ad:

> *"If you implemented, say, YouTube advertising as it is right now into VR, that would be pretty rough. Watching something, you're feeling something, then all of a sudden BAM focus shift; you're dealing with camera, focal length, all sorts of things like that that can be motion sickness inducing"* (P16).

In fact, this shift in interaction mode also presented challenges for immersion and physical harm. Per P14:

> "*I use VR a lot for passive stuff, like big screen to watch a movie when I'm sitting on my couch, if I'm presented with an ad to where now I have to swing my arms around to play a game, that would be very annoying to me because I'm already in the mode of just wanting to sit back and enter a passive experience.*"

Participants also worried that risks of physical harm could be exacerbated if VR ads could not be skipped. In this context, P15 highlighted the importance of quick exit options for VR experiences and VR advertisements:

> *"Once you're in that headset, you're kind of trapped into whatever experience you get thrown into. And so I think that there must be a way if you were in some sort of a known advertising space to just exit that or get out of it, are immediately departed if you find that it's something that is either physically or emotionally or mentally uncomfortable."*

Immersion could be used to manipulate vulnerable populations. One worry participants' had about VR ads was the possibility of manipulation in VR. These concerns were about manipulation in advertising broadly, not just VR advertising. However, participants believed that the fun and immersiveness of VR advertising could be used to trick and manipulate vulnerable populations, particularly children, senior citizens, and compulsive shoppers, in that ads could be made to be too enticing and convincing to resist.

> *"I know online right now it's already really easy for people to purchase it. But with VR, if they can actually feel the fabric and then try it on [...] I feel like it makes it even easier for them to buy it, but be like, try it on looks nice, buy it, buy it, buy it"* (P5).

P12 worried about cases where fun and engaging VR ads were used to promote dangerous products:

> *"Let's say instead of a video advertisement for alcohol, it's a world and you go and you can pick the drinks and you drink them and you physically have effects because that's something you can do in VR. You'll make everything a little 'woooo', and then there's kids who are impressionable people or even adults who let's say are trying to avoid alcohol. And then you're put in a non-skippable world where you're standing in a bar [...] I feel like the immersive nature of VR really makes that substantially more dangerous than just watching a video of that exact same thing."*

Relatedly, a few participants were worried that shopping could become too easy in VR. Certain affordances of the headset could reduce barriers and friction regarding shopping, making it dangerously easy to buy products. P19, for example, discussed how a lack of friction could exacerbate predatory advertising practices:

> *"Well, depending on how linked everything was, they could inside a VR potentially have a buy button where, without even taking off the headset, you could click buy it now, and that could make it remove a barrier to purchase. That might make it worse."*

Similarly, P6 highlighted how VR could make it easier to lose track of money that was being spent:

> *"I guess the negatives [of VR advertising] would be just because of the immersion, it's probably a bit easier to get lose track of your finances and stuff like that when you're presented with ads."*

Some participants further wondered what negative psychological impacts manipulative techniques might have beyond simply

purchasing the wrong products. P12 worried about VR advertising that leveraged people's sensitivities, and how this might affect children:

> *"I would be worried about a lot of body or weight-based things. There's a lot of young people in VRChat. [...] I would hate to see, let's say it's a world, it's [an] advertising world that it, it's puts you in and looking at yourself in a mirror and it makes you a bigger person and then makes you a smaller person."*

P6 worried about VR advertising being used to radicalize users, saying:

> *"It's more almost a subliminal type of brainwashing [...] I think probably would be a bit more pervasive in VR just because you are so immersed and if there's a trusted person or actor that you're into with VR, that person over time can turn you to something that you're not prepared to be."*

Thus, worries about manipulation extended beyond an immediate purchase, but more broadly, as to how participants viewed themselves and the real world.

5 Discussion

Our study answers two research questions. First, *what are VR user's experiences with VR advertisements?* We find that participants have already encountered various forms of VR advertising. These include very primitive types of advertising (e.g., banner ads), but also more complex and sophisticated experiences that appear unique to the VR context, including expansive and fully interactive virtual markets.

Second, *what are VR users' attitudes towards current and future VR advertisements?* We found participants were generally wary and skeptical about VR advertisements and distrusted VR advertisers, but many participants acknowledged potential benefits of VR advertising, including monetizing the space, creating new ways for consumers to interact with products, and creating fun and novel advertisements. With regards to concerns, participants were concerned about VR ads being intrusive and ruining the immersion of VR experiences; VR ads being forced on users and annoying to interact with; privacy risks; and physical harms.

In this section, we discuss the significance of our findings. First, we situate our findings in prior work, discussing how our work extends what is known about consumers' attitudes towards advertising by studying advertising in a new context (VR). We then discuss ways to align VR ads with VR users' needs and wants: in particular, VR ads should be contextually aware and provide user choice. Similarly, we caution those designing VR ad blockers to carefully balance VR ads with user immersion. Finally, we discuss limitations of our work.

5.1 Comparison with prior work

Our findings extend prior work by studying attitudes towards advertising in a new context (VR): while many studies have examined peoples' attitudes towards advertising, to our knowledge, we are one of the first to look at peoples' attitudes towards VR advertising. In many ways, our findings largely align with prior work on non-VR advertising, such as finding that consumers generally hold negative views towards advertisements [77], and that key concerns include blocking access to content [49], irritation [49], manipulation [63], and privacy risks [63]. Our findings not only reinforce this prior work, but show how concerns about advertising can be technology agnostic, with concerns about past forms of advertising informing how users feel about advertising in emerging technologies.

In addition, we highlight unique attitudes towards VR advertising. First, while concerns were similar, many participants worried over how existing harms, such as privacy risks or manipulating vulnerable populations, could be made worse through VR, such as through greater data collecting capabilities or through the immersion of VR making products irresistible, echoing prior arguments made by other scholars [39]. Similarly, participants were concerned that the possibility of eye-tracking in VR could mean advertisers collect even more sensitive data and can make their ads even more irritating and unskippable; or how shocking content could be worse in VR in that it would be more graphic, visceral, and difficult to avoid. Perhaps most importantly, our findings highlight the role that VR advertising could have in terms of ruining, but also *enhancing*, immersion. Prior work has found that people sometimes find ads to be annoying [49]; in VR though, ads may not only be irritating but may ruin the essence and experience of being immersed in VR by reminding users of the real world and bringing them out of the virtual environment – causing a break-in-presence (BIP). If done right, however, there may be instances where VR advertising could *enhance* the immersion of VR experiences (e.g., by having ads in places where one may expect to have ads). Aside from exacerbating existing harms, we unearth novel potential harms of VR advertising. Our participants who had experience using VR were able to point out additional harms that have so far not been prominently spoken about in the literature, including rough transitions between VR ads and VR content causing nausea or motion sickness, as well as the physical harms advertising can bring.

Finally, we find that participants had nuanced views towards advertising, balancing both the positive and negative aspects that advertising could bring. It might have been easy to assume that most VR users would be opposed to VR advertisements, as evidenced by public backlash against early attempts at VR advertising [35]. We can further compound on this with our own personal experiences running this study, whereby we received numerous negative comments in our recruitment posts (some insulting us and using foul language). However, our participants indicated that VR advertisements could have some benefits, including how VR ads can be fun, informative, and how they might help monetize the VR ecosystem and push it to new heights, as well as reward and help out small creators. This is reminiscent of prior work on consumer attitudes towards advertising, such as work finding that users find targeted advertising to be creepy yet useful at finding products [68]. These positive attitudes, of course, does not downplay or override the concerns that participants raised. In our sample, the overall sentiment was more negative than positive. Moreover, we need to caveat our findings in that our sample is not a representative sample of all VR users, and our findings should not be construed as generalizable. Having said that, our findings indicate that the assumption that all ads are perceived negatively needs to be questioned in the VR context, and that there may be a portion of VR users who appreciate,

and would like, VR ads as long as they are designed well and appropriately integrated into the virtual experience. Future work can and should explore this in more detail, including quantifying how much of a positive sentiment exists among VR users, and whether these positive sentiments outweigh the negative sentiments.

5.2 Creating a VR Ad ecosystem that aligns with users' needs and wants

Our findings provide valuable takeaways for key stakeholders that are seeking to create a VR environment that best aligns with users' needs and wants, and for addressing users' concerns with regards to VR advertisements.

Implications for Design. From a design perspective, our findings showcase the importance of user choice and contextual awareness in the design of advertising. Regarding user choice, our findings show that participants were particularly fearful of being constantly bombarded with advertising, and highly valued the flexibility of choosing when and how to engage with VR ads. VR provides interesting possibilities for user choice of when, how, and if, to engage with an ad. For example, in a VR game, when a player finishes a level, there could be a door that opens to the next level, and a different door that opens for an ad. But crucially, the door for the ad should be opt-in and the user should be able to ignore it without it impacting their gameplay. Alternatively, the choice could be presented to users before they enter a VR experience: the users could be told through a text bubble "Do you want to experience the following VR experience with or without advertising"; in the case the user selects advertising, the VR world contains product placement. In the case the user selects an option without advertising, the same world is generated with generic brands of products instead of named brands (e.g., a blank soda bottle instead of a 'Coca Cola' soda bottle). The choice should also extend to users choosing what data (if any) they are willing to share with advertisers in order to mitigate privacy risks and alleviate privacy concerns around inappropriate data collection. VR ads should further not block content, nor should they condition access to experiences with engaging with advertisements. And importantly, VR ads should not be forced on a user's headset and be unavoidable.

Companies might be reluctant to create ads that users can skip since they may feel like they lose user engagement. However, VR users did mention that they willingly engaged with unforced advertisements (for example, some of our participants freely chose to travel to virtual markets, or invited friends to try out virtual ads), showing that interesting and novel opportunities provided by VR advertising could be beneficial to both users and companies. If anything, optional ads that emphasize user choice may increase appreciation for the company who created the ad, since forced ads may foster resentment, whereas our participants did not seem too upset at the ads they encountered in VR that were not forced on users (e.g., posters in the distance users could choose to walk up to) – by contrast, many users were pre-emptively upset at Meta over the belief that Meta would bombard them with inescapable ads. Thus, companies should focus their efforts on making VR ads fun and experiences users want to engage with, not on making ads unavoidable.

With regards to contextual awareness, VR ads should, to the extent that it is possible, be contextually aware of the VR experience they are part of and try to match it. Contextual advertising is not new: it already exists in non-VR environments [79], such as search engines showing ads for products relating to a user's current search term [15]. In VR, contextual advertising takes on a new dimension by embedding advertising into VR experiences in ways to enhance rather than break their immersion. Our findings suggest that VR ads that align with the VR context in which they appear are likely to be perceived more positively than those that are 'out of place' in a given VR experience. For example, some of our participants suggested that for VR experiences that aim to recreate real-life places, there could be ads that would already be in those places. Using a similar logic, in experiences that are not based on real places, advertisements should promote products related to that experience: for example, a virtual experience that relates to rock climbing could advertise rock climbing gear, but perhaps not diapers. Similarly, the interactions required for in-app VR ads should closely match the interactions of the VR experience the ad is in. If the VR experience the user is engaging in is passive, then an embedded VR ad should not require a lot of movement or hand gestures to interact with. This could maintain immersion, but also reduce the chances of physical injuries that were raised by our participants and prior work [39].

Finally, there is an important balance to be struck between subtlety and user awareness. On the one hand, subtle ads (e.g., native advertising, product placement) are less likely to interrupt the flow and feeling of immersion (in fact, one of our participants said they would prefer product placement in VR over more conspicuous forms of advertising). On the other hand, disguising ads as non-advertising content could confuse users as to what is authentic content and what is content that was paid to be there – under many schools of thought, disguising advertising content is considered a manipulative tactic [19]. This showcases the importance of understanding what are ways to notify users of ads in ways that inform but do not disrupt.

Implications for Regulation. From a regulatory perspective, one important takeaway from our work is that VR ads are already being seen and experienced by ordinary VR users. They are no longer a theoretical construct or tech demos by companies; they are being used by companies large and small to advertise to users. While current VR ad examples, at least per our participants, seemed relatively benign, the fact that they are out there at all showcases how quickly they are developing, and by extension, how quickly they could harm users should VR ads start presenting harms. Moreover, while we could not prove that this was a scam, P20 did encounter advertisements for cryptocurrencies that seemed suspicious. This raises the stakes with regards to both the development of advertising and addressing harms within them. It is imperative to shape norms and regulations *now*, while the space is relatively malleable, so as to better align with VR users needs and wants. Our findings shed insights as to key concerns users have that warrant attention: the frequency and prevalence of advertising in VR; whether VR ads can block access to content (they should not); physical harms; and advertising of dangerous or sensitive products (e.g., alcohol). While numerous jurisdictions have laws governing advertising, these laws

were mostly made for non-VR contexts. They need to be updated to account for the unique context VR provides, including the increased immersion offered by VR and the inescapability of the headset [39].

Moreover, the lack of trust our participants had towards VR advertising companies means that the government needs to play a role. Currently, while many legal jurisdictions have laws regulating advertising (e.g., banning false or misleading advertising, or controlling what can be advertised to children), the advertising industry also has a large element of self-regulation, and many of the intricate details of how advertisements are to be are left up to individual companies [17]. This showcases that legislation governing VR advertising should be detail oriented, rather than leaving details (e.g., how often one can show ads to users) up to companies.

One area that presents challenges is how to handle notifications or labeling of subtle advertising in VR. Many legal jurisdictions have laws governing, and requiring, advertising disclosures. For example, the US Federal Trade Commission (FTC) requires advertisers to clearly indicate to consumers when advertisements occur [18]. These requirements were made for non-VR advertising, and while the spirit of this initiative is laudable (inform consumers of when they are being advertised to), care needs to be taken to figure out how to do so in VR in ways that inform users of the ad without ruining immersion. This is not a unique issue to advertising, (e.g., privacy disclosures). It is here that research should come in to help out. There already has been some work exploring what 'optimal' notifications in VR could look like: for example, work has found that notifications should be subtle, avoid jump scares, and only provide details on demand [21, 51]. These studies investigated notifications at large, not for notifying users of VR advertising, but key takeaways from this work could be leveraged to design notices for VR advertisements.

Finally, while our findings focused on virtual advertising, we also unearthed a closely related phenomenon: that of virtual shopping and markets. We argue that regulation should take a currently look at this currently unregulated space. Whereas our participants liked virtual shopping markets, the ability to recreate a shop virtually and encourage consumption within could result in severe user risks. For example, virtual shops could be designed in ways that encourage consumption and consumerism, such as by the use of dark patterns [70]. Participants worried about VR advertisements that made products too enticing to resist, and such worries naturally extend to VR shops, where one can buy dangerously but seemingly playful and irresistible products right there from the storefront. Researchers can play a role here, carrying out studies to audit and examine this burgeoning space (e.g., what type of shopping is available in VR right now? How do shopping experiences change? Are there dark patterns in VR shopping experiences, and if so, what is their impact on users?)

5.3 Pitfalls to avoid when designing VR ad blockers

While our findings have implications for the design of ads, they also provide insights for the design of VR ad blocking technologies. Most notably, VR ad blockers should, to the extent possible, not ruin the immersion of a VR experience. For example, a naive approach to VR ad blocking could be to "black out" ads by overlaying in-app ads with a black screen. Alternatively, in a bid to highlight subtle ads for users, another approach could be to clearly label and draw attention to subtle VR ads (e.g., product placement). While these approaches would meet their goals of eliminating ads or making them more salient, they could also ruin the immersion of the experience, which may not be what the VR user wants as our findings suggest. In some instances, even if the removal of ads is done in a subtle manner, the mere act of erasing an ad could still ruin the immersion. For example, for a VR experience that has ads on billboards, seeing empty billboards devoid of content could be even less appealing than having the billboards have ads. As such, ad blocking approaches should take user immersion into account.

5.4 Study Limitations

Our sample size (22), while typical for most qualitative studies, means that our findings should not be construed as generalizable. Nevertheless, given the nature of the study (exploring user attitudes towards a new and emerging technology), the interviews still provide deep and rich insights.

Another factor limiting our generalizability is how most of our participants were recruited from a single platform (Reddit), although from different forums within this platform; and while participants came from various different countries, all countries were located in either North America or Europe, with a heavy North American presence (16). Similarly, the participant sample skewed young and largely male (16), which is however consistent with current VR user statistics [60–62]. Furthermore, all participants had some VR experience, meaning that concerns of VR non-users are missing from our study. Future work can and should cover missing perspectives, including recruitment from other platforms, from other countries, and include people who have limited or no experience using VR applications.

There may have also been self-selection bias with regards to our participants. Would-be participants who viewed our survey may have thought we were VR advertisers, and those who viewed advertising negatively may not have participated out of a fear of indirectly contributing to VR advertising. However, the answers we received in the screening survey and the interviews make us confident that some participants viewed advertising negatively, and we stratified our sample along positive, neutral, and negative general attitudes towards advertising. Thus, while we cannot say what percentage of VR users have negative or positive views regarding advertising, we are confident that both positive and negative voices are represented in our study.

The second part of our interview protocol asked participants to imagine what VR advertising may look like in the future, meaning participants were responding in this part to what they imagined VR advertising could be, rather than what VR advertising currently is. This was necessary given the limited reach of current VR ads. Having said that, even if our participant's predictions regarding the future of VR advertising may not bear out, the concerns and hopes participants expressed regarding future VR advertising are still meaningful. Thus, the insights are still relevant to understanding what participants are concerned about regarding VR advertising.

6 Conclusion

In this study, we interviewed 22 VR users to understand their experiences, attitudes ,and concerns regarding VR advertising. We found that participants were generally apprehensive about VR advertising, primarily concerned about VR ads ruining immersion of VR experiences, VR ads being unskippable and forced on users, and privacy risks.

Our work provides insights for mitigating risks of VR advertising and creating a VR advertising environment that best aligns with users' needs and wants, including emphasizing choice and transparency, contextually-embedded advertising, and the importance of respecting the immersion of VR experiences, both in developing and blocking VR advertising.

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A Screening Survey

(1) I confirm I am 18 years of age or older and I consent to the participation in this study
  (a) Yes
  (b) No

A.1 Section 1: Experience using virtual reality

(2) When did you start using Virtual Reality (VR) headsets?
  (a) Over 5 years ago
  (b) Between 3-5 years ago
  (c) Between 1-3 years ago
  (d) Between 6-12 months ago
  (e) Within the last 6 months
  (f) I have never used VR
(3) On average, how often do you use VR?
  (a) Daily
  (b) A few times a week
  (c) A few times a month
  (d) Less than monthly
  (e) I do not use VR
(4) What VR headsets have you used before? Please check all that apply.
  (a) Oculus Rift
  (b) Oculus Quest / Oculus Quest 2
  (c) HTC Vive
  (d) Valve Index
  (e) HP Reverb G2
  (f) Other: _____
(5) What do you use VR for? Please check all that apply
  (a) Gaming
  (b) Education
  (c) Work
  (d) Social VR
  (e) Watching videos
  (f) Fitness and/or well-being
  (g) Other: _____
(6) Please list up to five of your most used VR applications.

A.2 Section 2: Attitudes towards advertisements

Now we are going to ask about your attitudes towards advertising.

Please rate how you feel about advertising along the following dimensions. In general, I find advertising to be...
Likert items ranging from 1 to 7

(7) Good — Bad
(8) Valuable — Worthless
(9) Important — Unimportant
(10) Pleasant — Unpleasant
(11) Necessary — Useless
(12) Positive — Negative
(13) Sincere — Insincere
(14) When visiting websites (like news websites, social media, etc.), how much do you like seeing ads? *Likert item ranging from Extremely Dislike to Extremely Like*
(15) Do you use an ad blocker on your computer or mobile device? (e.g., AdBlock, AdBlock Plus, uBlock Origin, etc.)
  (a) Yes
  (b) No
  (c) Unsure
  (d) Other: _____

A.3 Section 3: Experience with VR Advertisements

(16) Have you ever encountered any advertisements whilst using VR? This can include in-app VR advertisements or standalone promotional VR experiences.
  (a) Yes
  (b) No
  (c) Unsure
(17) (If you have answered yes to the above question) Please describe in a few sentences the advertisement that you encountered whilst using VR (e.g., what product was being advertised, what did the advertisement consist of, etc.)

A.4 Demographic Information

In this next section we want to collect some demographic information about you. We do this to better understand the groups of people we are interviewing, which will allow us to contextualize our findings and understand what perspectives are being represented.

(18) What is your age? (If you prefer not to disclose, please enter N/A)
(19) What is your gender? Check all that apply.
  (a) Man
  (b) Woman
  (c) Non-Binary
  (d) Prefer not to disclose
  (e) Prefer to self-describe
(20) If you prefer to self-describe your gender, please elaborate here.
(21) What is your race or ethnic background?
(22) Please describe your race or ethnic background. You can use general terms such as White, Latino, Black, Arab, or Asian or you can use more specific terms like Irish, Mexican, Hawaiian, or Navajo. You can use more than 1 term if you like. If you'd prefer not to disclose your race / ethnicity, please write N/A.

(23) Which is your current country of residence? (If you'd prefer not to say, write N/A)
(24) What is the highest level of education you have completed?
  (a) Some high school
  (b) High school or associate degree
  (c) Undergraduate degree
  (d) Postgraduate degree
  (e) Prefer not to disclose
(25) What was your total household income before taxes during the past 12 months?
  (a) Under $15,000
  (b) $15,000 to $24,999
  (c) $25,000 to $34,999
  (d) $35,000 to $49,999
  (e) $50,000 to $74,999
  (f) $75,000 to $99,999
  (g) $100,000 to $149,999
  (h) $150,000 or above
  (i) Prefer not to say

A.5 End of survey

Thank you so much for completing the screening survey! Please enter your name and email below. If you are selected for the study, we will contact you through that email to schedule an interview.

(26) Name
(27) Email
(28) OPTIONAL Where did you hear about this survey? (E.g., a particular subreddit, a facebook group, etc.)
(29) OPTIONAL Is there any additional information you want to share with us?

B Interview Protocol

(1) Introduction (5 mins)
  Goal of section: introduce the study, verify that participants are ok being recorded.
  Thank you for agreeing to be a part of this study! Like we mentioned in the recruitment email, in this study we want to understand VR users' attitudes towards VR advertising. The interview should last around 60-90 minutes.
  Before we begin, we want to make a note that we will be recording this interview for transcription purposes. This will be used in subsequent data analysis. All your responses will be kept anonymous, and while quotes may be used in papers or presentations, the quotes will be anonymized and delinked from you. You may stop the interview at any time. Do you have any questions about the process before we begin? I am about to start the recording.
  [Start Recording]
  I have turned on the recording. Please confirm you are ok with being recorded by saying "I consent to the participation in this study".
(2) Thank you so much! So first, I want to ask about your general attitude towards advertising. In your screening survey, you had [generally positive / generally negative / mixed] views towards advertising. For example, [GIVE EXAMPLE]. Could you expand on your answer?
  (a) Think about the ads you see when browsing social media or news, on your computer or your phone. What kinds of ads do you like seeing, if any?
  (b) What kinds of ads do you dislike the most, and why?
    (i) Are there specific ads that you remember disliking?
    (ii) Is there a type/genre of ad that you dislike in general?
    (iii) Do you see more ads that you dislike on certain apps or websites?
(3) For the next part, I want to talk more about virtual reality. First, if you could tell me a little bit about your experience with VR, how long have you been using Virtual Reality headsets?
  (a) What made you want to use VR?
  (b) What types of applications do you use VR for?
  (c) Which headsets do you use?
  (d) How often do you use VR?
(4) Have you encountered advertising within a VR app, such as in-app VR advertisements, or standalone promotional VR experiences?
  (a) Please describe the ad(s) you saw.
  (b) What was your reaction to the ad?
  (c) How often do you encounter VR ads?
(5) What about shopping apps or other VR content aimed at selling or promoting products?
(6) How likely is it for VR ads to increase?
(7) Do you want more ads in VR? Why or why not?
  Thank you for that! I want you to imagine a futuristic world where both VR usage and VR advertising is commonplace. I'll let you think for a few minutes about what that world is like, and then I will ask some questions about it to understand

what advertising is like in that world. I'll give you a minute or so to think about it.

(8) What are the main benefits, or positives, of widespread use of VR? Any drawbacks?
(9) How do you view ads in that world?
(10) What are the main benefits, or positives, of VR advertising?
(11) Are you excited about any particular aspects of VR advertising?
(12) What are the main drawbacks, or negatives, of VR advertising?
    (a) Do you have any concerns or worries about VR advertising?
    (b) Are there steps that could be taken to address these concerns and make VR ads acceptable?
        (i) For example, guidelines, certain legislation…
(13) In what contexts would advertising be useful / would you want advertising? In what contexts would you not want advertising?
(14) How different is VR advertising from non-VR advertising?

Thank you so much! Before concluding this interview, I had two questions to ask:

(15) First, are there any questions you expected me to ask but I did not?
(16) Second, are there any final comments you want to make on the record? There will be time after this where I will stop the recording and you can ask questions there if you are more comfortable.

C Codebook

Code	Description
General ad thoughts	Participant thoughts and attitudes regarding non-VR ads.
General ad benefits	Participant expresses benefits, advantages, and/or positives of non-VR ads.
General ad drawbacks	Participant expresses drawbacks, disadvantages, and/or negatives of non-VR ads.
VR ad benefits	Perceived benefits of VR ads.
Fun interesting novel	Participant expresses that ads can be fun or interesting and novel.
In context	Participant mentions that VR ads can have positive effects if shown in the appropriate context.
Increase realism	Participant expresses that VR ads can enhance the realism of certain experiences (for example, a VR experience that recreates Times Square can have in-app ads to make it feel more like Times Square).
Interactivity	Participant mentions that VR ads can be interactive.
Misc ad benefits	Participant highlight benefits, advantages, and/or positives of VR ads not captured by the other codes.
Monetization	Participant mentions that one advantage of VR ads is that it can help monetize the space. Also includes references to maturing and legitimizing the scene.
Lack of concern	Participant expresses a lack of concern over VR risks because of optimism downplaying the severity of these risks.
Practical	Participant mentions that VR ads can be practical or useful.
VR ad drawbacks	Perceived drawbacks of VR ads.
Ad bombardment	Participant mentions concern over VR being bombarded and overrun by ads,
Breaking immersion	Participant mentions that advertisements can break immersion in VR or interrupt the experience.
Children	Participant mentions being worried about ads targeting children or about children seeing inappropriate content.
Consumerism	Participant mentions that VR advertisements can increase consumerism or take advantage of people with compulsive shopping disorders.
Don't trust companies	Participant expresses distrust in companies in charge of VR or in charge of VR advertisements.
Forced	Participants express concern they will be forced to watch ads or that ads are unavoidable.
Indifference	Participant mentions being indifferent and not caring about VR ads in VR.
Low quality	Participant expresses concern that VR advertisements will be of low quality.
Manipulation	Participant expresses concern regarding VR advertisements being manipulative.
Misc ad drawbacks	Participant expresses other drawbacks, negatives, and concerns regarding VR ads not captured by the previous codes.
Physical harms	Participant mentions that VR advertising can cause physical harm to users.
Obtrusiveness	Participant mentions that VR ads can be obtrusive, intrusive, or that they 'get in the way' of things.
Privacy concerns	Participant expresses concern regarding the privacy risks that VR advertisements pose.
Resignation	Participants express resignation towards ads in VR, seeing VR advertisements and problems within them as inevitable, unavoidable, or another part of life.
VR ad solutions	Solutions participants mentioned that would solve some of the concerns regarding VR ads.
Government regulation	Participant mentions that government regulation can be used to solve problems associated with VR ads.
VR ads per participants	Participant predictions regarding VR ads.
Ad frequency	Participants mention that the frequency of ads will either change or stay the same over time.
Payment matters	Participant mentions that whether the app is paid or not largely affects their attitude or perception regarding VR ads.
VR ad diff	Participants talk about the main differences they see between VR ads and non-VR ads.
VR ads desired	Participant talks about what types of VR ads they would want to have.
Subtle ads	Participant mentions desiring subtle forms of ads in VR, such as product placement.
VR ads encountered	Participant talks about the VR advertisements they have encountered.
VR ads imagined	How participants imagined VR ads would be like in the future.
Digital avatars salespeople	Participant mentions that in the future, VR ads will feature digital avatars and salespeople that sell products to the consumer.
MR AR blending	Participant mentions that in the future, VR will not be purely VR, and instead, will incorporate elements of Augmented and Mixed reality.
Rely on priors	Participant bases their opinions on what VR ads could be like based on their experiences with non-VR ads.
Rely on science fiction	Participant bases their opinions on what VR ads could be like on science fiction.