

## Rethinking methodologies to study immersive experiences in the food context

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### Abstract

This research note examines the phenomenological dimensions and methodological challenges encountered when empirically studying immersive consumer experiences. The study focuses on the use of Extended Reality (XR) technologies in a wine tasting context, with the objective of reflecting on the suitability of traditional experimental paradigms for capturing immersive experiences. We report findings from a mixed-methods study comprising a between-subjects experiment comparing two immersive formats (VR CAVE vs. VR headsets) with 111 participants, followed by interviews with a purposive sub-sample of nine participants. While XR environments offer promising opportunities for consumer engagement, the quantitative results did not support the hypothesized mediation effects, prompting a qualitative follow-up to explore underlying experiential and procedural factors. The qualitative analysis reveals that Immersion Inhibition Bias, social presence dynamics, and the temporal structuring of experimental procedures can significantly constrain participants' ability to enter immersive experiential states. Rather than positioning the experiment as a definitive empirical test, this research note uses the study as a contextual background to expose methodological tensions inherent in immersive experience research. Based on these insights, we propose methodological directions for future studies, including hybrid experimental designs embedded in real-world settings, longitudinal immersion approaches, and multimodal data collection incorporating physiological measures. By advancing methodological reflection on immersive experience research, this research note contributes to ongoing debates on immersive experience design and measurement, with implications for both academic research and industry practice.

**Keywords:** immersive experience, XR, wine tasting, research methodology, consumer behaviour.

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## 1. Introduction

Extended Reality (XR) technologies have emerged as prominent concepts in innovative and future-oriented industries. As a result, research examining the implications and mechanisms of XR across domains has increased substantially in recent years. XR is commonly defined as an umbrella term encompassing immersive technologies, predominantly driven by Augmented Reality (AR) and Virtual Reality (VR) formats (Rauschnabel *et al.*, 2022). In marketing and related fields, XR has been positioned as a technology with high experiential potential, with studies examining consumer engagement through immersion (Deng *et al.*, 2019), visitor experiences in tourism contexts (Belo & Gustavo, 2024; Israel *et al.*, 2019; tom Dieck *et al.*, 2018), and behavioral outcomes such as social media sharing and purchase intentions (Sung *et al.*, 2022a; Sung *et al.*, 2022b).

Within foodservice and hospitality research, however, empirical investigations into the use and effects of XR on immersive consumer experiences remain relatively limited (e.g., Han *et al.*, 2022). Existing studies in wine-related contexts suggest that immersive and digitally mediated experiences can positively influence consumer responses. For example, Pelegrín-Borondo *et al.* (2020) demonstrated that positive emotions triggered by perceived novelty significantly affect wine purchase intentions, while Wen and Leung (2021) showed that VR-based virtual wine tours result in higher purchase intention and willingness to pay compared to 2D video formats. Their findings further indicate that combining online and offline embodiments of experiences can strengthen behavioral effects. In the broader food context, immersive XR spaces such as projection-enabled VR CAVE (VR Cave Automatic Virtual Environment) formats have been shown to facilitate unobtrusive, group-based experiential engagement (Dionisio *et al.*, 2013). Despite these promising findings, the scope of immersive experience research in food contexts remains underexplored, with prior work relying predominantly on qualitative designs, thereby limiting insight into the underlying mechanisms driving experiential and behavioral outcomes.

Across immersive technology research in the food context, studies conducted in realistic consumption settings remain scarce. Consequently, it is still unclear how different immersive formats, such as VR CAVE systems versus head-mounted VR devices, shape psychological and affective responses in real-world consumption settings, and how these responses translate into immersive experiences. Addressing this gap is particularly relevant for industry practitioners, who increasingly seek empirically grounded evidence to support the adoption of immersive technologies as tools for engaging consumers and stimulating behavioral change. In food contexts specifically, this calls for empirical studies that incorporate real food interventions, live tasting, and experiential settings that more closely resemble natural encounters.

Against this backdrop, we designed and conducted an experimental study using two immersive technology formats (VR CAVE vs. VR headset) to explore how different immersive environments influence wine-tasting experiences and subsequent behavioral intentions. Building on prior work comparing VR headsets and CAVE systems (Moonen *et al.*, 2024), our study aimed to extend existing insights into immersive learning and experience formation. However, our hypotheses were not supported by the quantitative results, and these unexpected findings necessitated a qualitative follow-up study, which raised broader questions regarding the suitability of traditional experimental design principles for immersive experience research. Recent research on immersive technology highlights that diverse empirical approaches and measurement instruments can yield divergent operationalizations of core experience constructs (e.g., presence, engagement), resulting in conceptual fragmentation and limiting comparability across studies (Bashar *et al.*, 2025). Cheiran *et al.* (2025) identified four distinct methodological pathways to address this methodological complexity, including questionnaires, physiological measures, interviews, and observations, each capturing different experiential facets,

underscoring the difficulty of achieving both psychometric validity and ecological relevance within a single study design.

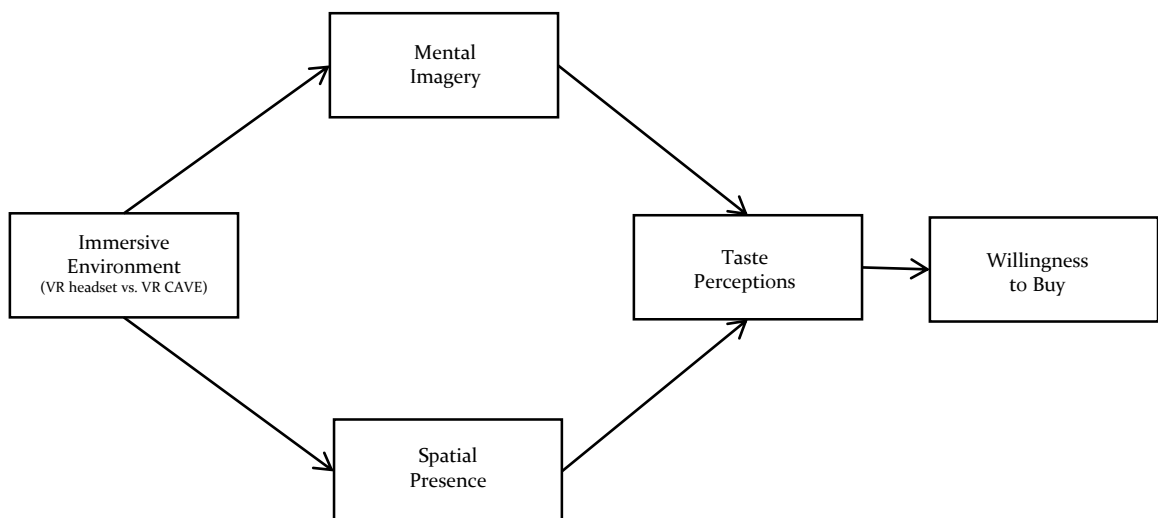
Thus, the results of our experimental study, while relevant for contextual background, are not the emphasis of this research note. Instead, we use the study as an empirical point of departure to critically reflect on methodological limitations inherent in studying immersive experiences through conventional experimental paradigms. The primary aim of this research note, therefore, is to stimulate methodological reflection and to call for alternative research designs better suited to capturing the complexity of immersive consumer experiences. In doing so, we contribute to both the human-computer interaction and immersive experience literature by highlighting the need for revised methodological approaches when studying immersive consumer experiences in food and hospitality contexts.

## 2. Experimental study context

We draw on extant literature from sensory marketing theory (Schöniger, 2022) and presence theory in the immersive technology context (Di Dalmazi et al., 2024; Erensoy et al., 2024) to reason that immersive XR spaces like VR CAVE systems that can contextualize consumers' immediate environment can affect consumer experience and resulting behavioral intention. In addition, we incorporated taste perception as an influencing variable in our study due to its strong relevance in the wine tasting experience context, as "taste never stands apart from the social contingencies and the discursive practices that are developed to describe it" (Fele & Liberman, 2021, p. 40). Specifically, we reasoned that, because VR CAVEs can create highly immersive yet inconspicuous experiences, they would increase consumer willingness to buy indirectly through mental imagery, spatial presence, and taste perceptions. Formally stated, and as depicted in Figure 1, we hypothesized:

**H<sub>1</sub>:** VR CAVEs (vs. VR headsets) will increase consumers' willingness to buy serially through mental imagery and taste perceptions

**H<sub>2</sub>:** VR CAVEs (vs. VR headsets) will increase consumers' willingness to buy serially through spatial presence and taste perceptions



**Figure 1.** *Conceptual model*

### 2.1. Experimental design and participants

We designed a single-factor between-subjects experiment with two conditions (immersive environment: VR CAVE vs. VR headset). The stimulus for both conditions was a Tuscan vineyard scene. The experiment was conducted in an immersive experience lab at a Dutch university. Participants were approached and recruited from two Dutch universities using convenience sampling and invited to participate in a wine tasting. A total of 111 participants completed the study (44.1% male; 55.9% female; Mage = 29 years).

### 2.2. Procedure

Participants were randomly assigned to one of the two immersive environment conditions (VR CAVE or VR headset). All participants completed the experiment in the same lab space and were provided with the same setup, which was pre-set before entry to the lab: 30 mL of wine pre-poured into a wine glass, a glass of water, a small dish of plain tasting crackers, and an iPad pre-loaded with the study questionnaire. To control for taste associations based on prior experiences with a specific wine brand, all wine was poured out of sight from the participants, and the same style of wine glass was used in both conditions to control for the potential influence of haptic properties (Krishna *et al.*, 2024; Krishna & Morrin, 2008).

Upon arrival at the lab, participants were checked in and their age was verified. Participants then entered the lab and were seated at separate tables. In the VR CAVE condition, the Tuscan vineyard scene was projected onto the walls. In the VR headset condition, the walls were white, and participants were given a Meta Quest 3 VR headset that displayed the same Tuscan vineyard scene, migrated to the headset as a 270-degree field-of-view video. In both conditions, stereo audio was used, which was realized in the VR CAVE setting through two speakers attached to the left and right sides of the ceiling in the room, and in the VR headset through the standard headset attached to the Meta Quest 3 glasses. In both conditions, participants were asked to sample the wine provided and then complete the study questionnaire.

The questionnaire included measures for willingness to buy (Donato & Adiguzel, 2022), mental imagery (adapted from Babin & Burns, 1998), spatial presence (adapted from Hartmann *et al.*, 2016), and taste perceptions (Orlowski *et al.*, 2022). We also included an overall measure of perceived immersion (Hudson *et al.*, 2019) and a measure of wine familiarity (Orlowski *et al.*, 2022). Three attention check questions were interspersed throughout the questionnaire, and the questionnaire closed with demographic questions.

### 2.3. Quantitative results

To test our hypotheses, parallel and serial mediation analysis was conducted using PROCESS Model 80 with 10,000 bootstrap samples (Hayes, 2017). Wine familiarity was included as a covariate. Critically, and relevant to H<sub>1</sub>, the results revealed that the effect of immersive environment (0 = VR headset, 1 = VR CAVE) on mental imagery was not significant ( $a_1 = -0.29, p = .304$ ). The effect of mental imagery on taste perceptions was also not significant ( $d_1 = -0.10, p = .148$ ), although taste perceptions did have a significant, positive effect on willingness to buy ( $b_1 = 1.214, p < .001$ ). Thus, the serial mediation chain proposed in H<sub>1</sub> was not supported (estimate = 0.03, 95% C.I. = -0.030 to 0.158).

Relevant to H<sub>2</sub>, the immersive environment (0 = VR headset, 1 = VR CAVE) had a slightly significant effect on spatial presence ( $a_2 = -0.51, p = .05$ ). Spatial presence had a positive effect on taste perceptions ( $d_2 = 0.19, p < .05$ ), which in turn had a positive effect on willingness to buy ( $b_1 = 1.214, p < .001$ ). However, the serial mediation chain proposed in H<sub>2</sub> was not supported (estimate = -0.12, 95% C.I. = -0.294 to 0.003). The direct effect of immersive environment on willingness to buy was also not significant ( $c_1 = -0.18, p = 0.36$ ).

In light of these results, we ran an independent-samples t-test to assess whether participants' perceived level of immersion differed between the two immersive environment conditions. Results showed no significant difference in perceived immersion between the VR headset ( $M_{VR} = 3.86$ ) and the VR CAVE ( $M_{CAVE} = 3.92$ ,  $t(109) = -0.207$ ,  $p = .836$ ).

Thus, we consolidated the two conditions and re-tested our hypotheses to determine whether perceived immersion (regardless of the specific immersive environment) had any effect on willingness to buy, either directly or indirectly. Contrary to our original results, perceived immersion had a significant, positive effect on mental imagery ( $a_1 = 0.61$ ,  $p < .001$ ) and a strong positive effect on spatial presence ( $b_1 = 0.72$ ,  $p < .001$ ). A serial indirect effect of perceived immersion on willingness to buy through mental imagery and taste perceptions was still not supported (estimate =  $-0.07$ , 95% C.I. =  $-0.172$  to  $0.039$ ); however, the serial indirect effect through spatial presence and taste perceptions was supported (estimate =  $0.20$ , 95% C.I. =  $0.026$  to  $0.373$ ). Similar to our original model, the direct effect of perceived immersion on willingness to buy was not significant ( $c_1 = 0.07$ ,  $p = 0.50$ ).

### 3. Qualitative follow-up

Our quantitative results suggested that the absence of support for the hypothesized effects may reflect limitations of the experimental setting in enabling immersion. To examine whether procedural, contextual, or experiential factors constrained participants' ability to enter immersive states, a qualitative follow-up was therefore deemed necessary. We sought to gain insights into participants' lived experiences and sense-making processes, which are particularly relevant when studying immersive environments where psychological absorption and contextual awareness are central yet difficult to capture through standardized measures.

#### 3.1. Qualitative design and participants

We conducted semi-structured interviews with a sub-sample of nine participants from the quantitative study. Participants were selected using a purposive sampling approach to ensure variation in potential experienced immersion levels across both experimental conditions, thereby enabling exploration of divergent experiential responses rather than statistical representation. We adopted a sample size consistent with established recommendations for achieving thematic saturation in interview studies. A recent systematic review of sample sizes in qualitative research found that 9–17 interviews or 4–8 focus groups are typically sufficient to achieve saturation when exploring experiential and perceptual phenomena (Hennink & Kaiser, 2022). This range reflects a balance between depth and analytic sufficiency in studies that solely aim to identify recurring themes rather than to make population inferences.

#### 3.2. Interview protocol and data analysis

All interviews were conducted by the researchers in this study. An interview guide was used to ensure consistency across interviews while allowing flexibility to probe participants' individual experiences and reflections in greater depth. Sample questions included: "What do you remember of the wine itself?", "What do you remember of the scenery?", and "Can you describe how immersed you felt through the technology?". Interviews lasted for approximately 30 minutes and were conducted over Microsoft Teams; as such, in addition to any notes taken during the interview, all interviews were recorded and transcribed. Transcriptions and notes were imported into ATLAS.ti Web (version 9.18.0) and coded for themes following the guidelines provided by Braun and Clark (2012). To enhance analytic credibility, emerging themes were continuously compared with the raw data and discussed among three independent researchers to ensure alignment between participants' accounts and the theoretical interpretation. Several critical issues were identified through this thematic analysis, which shed light on the complex interplay between traditional experimental design and methodological constraints in immersive experience research.

### 3.3. Qualitative findings

#### 3.3.1. Immersion Inhibition Bias

A significant theoretical construct emerging from the analysis concerns what we term “Immersion Inhibition Bias”. We define Immersion Inhibition Bias as a persistent cognitive orientation in which awareness of the research context disrupts participants’ ability to enter immersive psychological states. Participants consistently demonstrated acute awareness of the experimental apparatus: *“It looked like more of a test kind of setup... everyone needs to look in front of them because of the projection”* (P7). This finding reveals a fundamental methodological paradox: the very protocols implemented in experimental research design may systematically undermine the unfolding of immersive experiences. As Participant 7 noted: *“When I feel like we’re in a setting where all of us are looking at the same thing, having to fill in the questionnaire... it feels like an experiment on the spot”*.

The pervasiveness of Immersion Inhibition Bias was evident across multiple participants’ experiences, with varying degrees of impact. One participant explained: *“Well, for me it was still a bit of a 2D and even if it was projected... of course, it’s better than only tasting the wine like I took that into consideration, but to try to imagine yourself in this surrounding. But I didn’t feel in the surrounding, I didn’t feel part of the surroundings”* (P3). This observation reinforces the idea that participants remain aware of the artificial nature of the experimental environment despite attempts to create fully immersive environments.

Further evidence emerged from another participant who explicitly acknowledged this awareness: *“I was always very aware of my environment, so although I sense the idea of the experiment, I was quite aware that I was in a room sitting next to other people in a school environment”* (P4). These accounts collectively demonstrate the persistent nature of Immersion Inhibition Bias as a methodological challenge.

One may reasonably question whether Immersion Inhibition Bias truly constitutes a fundamentally new phenomenon or rather a re-labelling of established methodological effects such as the Hawthorne effect or demand characteristics. While we acknowledge this conceptual proximity, we argue that Immersion Inhibition Bias represents a domain-specific manifestation of these broader effects distinct to immersive experience research. Whereas traditional observer effects concern behavioral modifications of participants or response distortion resulting from participants’ awareness of being studied, Immersion Inhibition Bias operates at the pre-experience stage by inhibiting the formation of immersive experiential states themselves. In immersive settings, the core object of inquiry is not task performance or decision accuracy, but the emergence and measurement of psychological, sensory, and spatial absorption. Our qualitative findings demonstrate that experimental protocols, such as visible research instruments and structured task sequencing or protocols that must be strictly followed, can prevent participants from entering immersive states altogether. This mechanism cannot be adequately captured by existing constructs that assume an experience has already occurred and is subsequently biased in reporting a modified behavior.

By introducing the concept of Immersion Inhibition Bias, we aim not to replace established methodological insights but to sharpen conceptual and methodological sensitivity to a failure mode specific to immersive experience research. Importantly, recognizing this bias shifts the methodological focus from controlling participant responses to reconfiguring research designs in ways that preserve experiential authenticity.

#### 3.3.2. Social and contextual dynamics for ecological validity

Our analysis revealed complex interactions between social presence and immersive experiences, particularly regarding the tension between controlled experimental conditions and ecological validity. The interviews highlighted how structured experimental environments can conflict with naturalistic

social behaviors: *"You will never sit there like this facing and yeah... because yeah, it looked like more of a test kind of setup"* (P7). The analysis also revealed nuanced perspectives on social presence, with some participants finding familiar social connections potentially beneficial for the experimental experience: *"For me, it was good because it was with colleagues that I knew and we kind of agreed to sign up together... So we kind of went in with, like, we're gonna have some wine. We're gonna participate in the study"* (P3). This observation illuminates the complex interplay between social familiarity and experimental consciousness, both before and during the research, which can influence participants' attitudes toward the study and, in turn, how they respond. Additional perspectives emerged regarding the impact of social presence: *"I remember people surround me...I remember, I believe [researcher] was there...it was not a lot of people but other people, yeah, not only me"* (P5). The variability in participants' responses to social presence suggests that the research context should consider participants' social context to allow natural behavior to embrace the immersive experience. Current methodological approaches often impose artificial behavioral constraints that may compromise ecological validity. Future research designs must incorporate more naturalistic social and behavioral patterns, as evidenced by participants' suggestions for environmental modifications: *"Maybe if the tables were a bit more random... just to feel that you are sitting somewhere like on a terrace"* (P7).

### 3.3.3. Temporal continuity and experiential flow

The thematic analysis also revealed significant challenges in maintaining temporal continuity within research protocols. Participants noted how transitions between experiential and measurement phases disrupted immersive states: *"The entry point and exit point should not interrupt the flow of the others because some people were done, and they needed to answer... I think it should be like this bubble of like where you experience it"* (P7). Temporal constraints emerged as a critical factor affecting the potential for immersion. One participant articulated this in stating: *"I think the time is maybe too short to get to come in this area. So, you are working and then you go to this room working. You are mentally...not how do you say that? Yeah. 'relaxed' (P2). This observation highlights how temporal constraints and transitions affect immersive potential, and researchers may need to consider mental preparation time as part of the overall research design when planning immersive experience studies. This was further evidenced by Participant 4: "I thought it was a bit short, I didn't really quite know what to expect... I think if it had been a bit more extensive that I really would have gotten into the whole experience". Immersive research designs require careful consideration of temporal aspects, including smoother space and time transitions between experiential and measurement phases. This may require innovative approaches to data collection that preserve experiential continuity.*

## 4. Discussion and propositions for new methodologies

Our qualitative analysis revealed fundamental tensions between traditional experimental methodologies and the naturalistic conditions required for authentic immersive experiences. Our findings suggest that studying immersive experiences may require a critical rethinking of traditional research paradigms, potentially moving towards more naturalistic and ecological methodological approaches that better preserve the authentic nature of immersive experiences while still maintaining scientific rigor. Studying immersive experiences poses significant methodological challenges, as demonstrated by our immersive wine-tasting experiment. The interplay between immersion, presence, and behavioral responses is complex, and traditional experimental designs often fail to capture the full extent of these phenomena.

One of the most prominent challenges identified in our qualitative follow-up was the emergence of Immersion Inhibition Bias, or the persistent cognitive orientation in which participants remain aware of the research context, thereby disrupting the immersive psychological states an experiment or simulation seeks to evoke. Many of our participants were aware of our experimental setup, which inhibited their ability to fully engage with the immersive experience. However, unlike observer effects,

which occur when participants modify or improve their behavior in response to being observed (i.e., the Hawthorne effect) or demand characteristic effects, which occur when participants attempt to guess at a study's purpose or hypotheses and alter their performance in the study accordingly (James & Vo, 2010; Zikmund *et al.* 2013), we propose that Immersion Inhibition Bias specifically interferes with sensory, emotional, and spatial absorption, thereby limiting the intended experiential impact and sense of presence of simulated or virtual environments. This aligns with previous findings suggesting that VR-based learning environments can suffer from a sense of artificiality, thereby reducing immersion effectiveness (Moonen *et al.*, 2024). The tension between controlled research conditions and ecological validity is a well-documented issue in immersive experience research. For example, Di Dalmazi *et al.* (2024) emphasize that presence and physiological arousal are critical in determining behavioral responses to immersive technologies, yet such responses may be suppressed when participants remain aware of the research context. These findings reinforce the significance of Immersion Inhibition Bias as a distinct effect within controlled experimental research settings and further highlight that achieving a balance between methodological control and experiential authenticity is crucial. Thus, we propose that future studies explore more naturalistic experimental designs that minimize participants' awareness of being studied or observed, such as embedding the study in real-world, living-lab settings (e.g., restaurants, wine bars) or using longitudinal designs in which participants engage with immersive technologies over an extended period.

Our qualitative findings further revealed that disruptions in temporal continuity significantly and negatively impacted immersion. Participants reported that the limited transition time between the experiential and data collection phases disrupted their ability to remain engaged in the immersive environment. This issue is supported by Schöniger (2022), who argued that engagement and sensory input must be sustained for immersive environments to effectively influence consumer perceptions. To mitigate these disruptions, future studies should consider integrating data collection methods that do not disrupt the flow of the experience. For instance, integration of physiological measurements, such as heart rate variability and galvanic skin response, could be used to assess engagement without requiring participant intervention (Bastiaansen *et al.*, 2019; Han *et al.*, 2022). Additionally, we propose adapting common experimental designs to facilitate seamless transitions between immersion and participant reflection. For example, participants could be asked to describe their experiences post-immersion in a conversational format, such as in the experience-reconstruction method (Kahneman *et al.*, 2004), rather than through structured questionnaires.

Social presence emerged as a double-edged sword in our study. While some participants found familiarity with co-participants beneficial for engagement, others perceived the structured experimental environment as unnatural, particularly in the context of wine tasting, which is generally experienced in a social setting. This finding aligns with Erensoy *et al.* (2024), who highlight the role of social presence in shaping immersive consumer behavior. The extent to which social dynamics enhance or inhibit immersion remains an open question and should be a focal area for future research. For instance, future studies could experiment with different social configurations, such as allowing participants to engage in immersive experiences individually, in pairs, or in larger groups, to assess how social context influences engagement and behavioral responses. Additionally, leveraging XR technologies that allow for remote, yet socially connected experiences could provide insights into how digital social presence compares to physical co-presence. While this may result in lower internal experimental design validity, as social dynamics may differ across groups, we need to pay more attention to adapting experimental design protocols to allow for interaction among participants. Social engagement is a key contextual factor in many experiential settings, such as dining, that shapes immersive experiences and thus should not be overlooked.

## 5. Conclusion

The methodological challenges presented in this research note highlight the need to rethink research approaches to studying immersive experiences. Traditional experimental paradigms may not fully capture the depth of immersive engagement due to issues related to research consciousness, temporal continuity, and social presence. Our findings underscore the need to refine research methodologies to ensure the authenticity and effectiveness of immersive experience studies.

Based on our findings, we propose several methodological approaches to study immersive consumer experiences: (1) hybrid experimental designs which integrate controlled experimental conditions with real-world settings to enhance ecological validity, such as deploying XR experiences in wine-tasting events rather than lab settings; (2) longitudinal immersion studies to measure the impact of immersive experiences over time, providing deeper insights into how immersion influences consumer behavior beyond initial exposure; and (3) multimodal data collection combining self-reported data with biometric measures, such as eye-tracking, EEG, or heart rate monitoring, to generate a more holistic understanding of immersion and presence.

By addressing these challenges, researchers can develop more robust insights into the impact of immersive technologies on consumer behavior, ultimately advancing the field of immersive experience research. This study contributes to the growing discourse on immersive methodologies and calls attention to the importance of refining experimental and qualitative approaches to studying immersive consumer experiences.

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