

Beyond the Five Senses: A Systematic Review of Multisensory Integration in the Age of Experience

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ABSTRACT

As experiential consumption becomes central to contemporary brand strategy, the integration of multiple sensory modalities is no longer confined to traditional marketing environments. This systematic literature review investigates how sensory stimuli extending beyond the classical five senses are co-designed within immersive technologies to enhance customer experiences in both physical and digital contexts. A total of 190 peer-reviewed articles published between 2014 and 2024 were analyzed from the Scopus and Web of Science databases. The review develops a conceptual framework that organizes multisensory marketing into antecedents, mediators, moderators, and outcomes, offering a structured lens for understanding emerging practices. Technological embodiments such as virtual reality (VR), augmented reality (AR), three-dimensional environments, and tactile feedback are identified as critical enablers of immersive experiences. Findings emphasize telepresence, or the sense of virtual presence, as a key mediator influencing affective and behavioral responses. Research gaps are noted in relation to technology typologies, user traits, and marketing effects, providing a future research agenda to guide both academic inquiry and managerial practice. This review advances multisensory marketing theory by positioning technological embodiment and telepresence as pivotal mediating constructs that bridge sensory design and customer experience within immersive environments.

Keywords: Multisensory marketing; Experiential consumption; Immersive technologies; Virtual reality (VR); Augmented reality (AR); Telepresence; Customer experience.

INTRODUCTION

In the era of experiential marketing, the boundaries of sensory engagement are rapidly expanding. Consumers increasingly seek immersive brand encounters that go beyond sight and sound, demanding experiences that engage multiple senses in meaningful ways. Digital innovations such as Virtual Reality (VR), Augmented Reality (AR), and the Internet of Things (IoT) have opened new possibilities for marketers to design environments that simulate physical sensations, trigger emotional responses, and strengthen the sense of telepresence. This review systematically explores how these technologies are applied within sensory marketing to co-create immersive environments that shape consumer perception and influence behavior.

Previous systematic reviews (e.g., Du et al., 2022; Xi & Hamari, 2021; Erensoy et al., 2024) have examined the use of AR and VR in marketing, yet most remain visually oriented, laboratory-based, and focused on broad taxonomic classifications. Several important limitations persist. First, earlier studies tend to overlook multisensory integration, particularly olfactory and haptic dimensions, and rarely report device-specific parameters such as latency, flow rates, or sensor placement, which are crucial for replication and methodological clarity. Second, most research relies on short, single-exposure experiments and self-reported measures, providing limited understanding of long-term habituation, learning processes, or biometric and behavioral responses. Third, evidence on boundary conditions, such as cue incongruence, sensory competition,

and temporal asynchrony remains limited, and few studies benchmark immersive modalities against practical baselines (e.g., desktop 3D or mobile video) to assess incremental effects. Fourth, little attention has been given to aligning marketing strategies with technological capabilities, evaluating key performance indicators (e.g., willingness to pay, basket size, repeat purchase), or scaling field applications across industries and cultural contexts. Finally, user heterogeneity, relating to factors such as age, olfactory sensitivity, susceptibility to cybersickness, and privacy attitudes, remains insufficiently theorized.

In addressing these gaps, the present review adopts a multisensory, technology-characteristics, and marketing-effects perspective. It underscores the need for methodological standardization, preregistered and multi-site research designs, and the inclusion of decision-relevant outcomes to strengthen both theoretical development and managerial practice in multisensory marketing within immersive environments.

This review examines how immersive technologies, specifically augmented reality (AR), virtual reality (VR), and multisensory head-mounted display systems, have been utilised to advance multisensory integration in marketing beyond predominantly visual approaches. It explores the underlying mechanisms and boundary conditions that shape consumer responses, including the roles of presence, affect, cue congruence or incongruence, and individual user differences. In addition, the review investigates the extent to which multisensory AR/VR interventions influence key marketing outcomes such as willingness to pay, repeat intention, and loyalty when compared to robust non-immersive benchmarks. Finally, it considers the methodological and technological standards required to ensure that such interventions are reproducible, scalable, and suitable for broader application in future marketing research and practice.

Background

Traditional multisensory theory (Spence, 2020; Peck & Wiggins, 2006) explains that consumer perceptions, judgments, and behaviours arise from the integration of multiple sensory modalities, shaped by mechanisms such as cross-modal correspondences, tactile engagement, and the influence of cue congruence or incongruence within embodied, context-dependent experiences. Building on this foundation, Fiorentino et al. (2022) demonstrate that immersive technologies such as AR, VR, and XR extend these principles by simulating or enhancing visual, auditory, olfactory, and haptic cues in programmable environments that mirror and enrich bodily interaction. These technologies allow sensory cues to be coordinated with high precision, shifting consumers from passive exposure to more active and participatory roles in shaping the experience. According to Kostyk and Bellman (2023), this shift brings important implications: traditional models must be refined to incorporate virtual embodiment and interactivity; brands gain new avenues to design immersive, congruent, and ethically mindful touchpoints; and researchers are able to test multisensory effects under controlled yet innovative conditions, including cue asynchrony, habituation, and individual differences. Overall, the linkage lies in how AR/VR/XR environments reinterpret and extend classical multisensory frameworks into digital contexts, transforming marketing from static presentation toward dynamic, co-created brand experiences.

Multisensory marketing draws its foundation from **experiential marketing theory** (Schmitt, 1999), which highlights five key modules: sensory, affective, cognitive, behavioral, and relational. With the rise of digital technologies, this framework has expanded to include escapist and utilitarian dimensions (Kacprzak, 2017), reflecting how consumers now seek both enjoyment and functionality in their experiences. Tools such as virtual reality (VR) and augmented reality (AR) allow marketers to go beyond sight and sound, simulating touch, scent, and even taste to create deeply personal and memorable encounters. To better understand how these immersive technologies shape engagement, Flavián et al. (2019) introduced the **Embodiment-Presence-Interactivity (EPI) Cube framework**. Figure 1 below shows how this model emphasizes three interlinked dimensions—technological embodiment, perceptual presence, and behavioral interactivity—that together influence how customers connect with and respond to brand experiences in virtual environments.

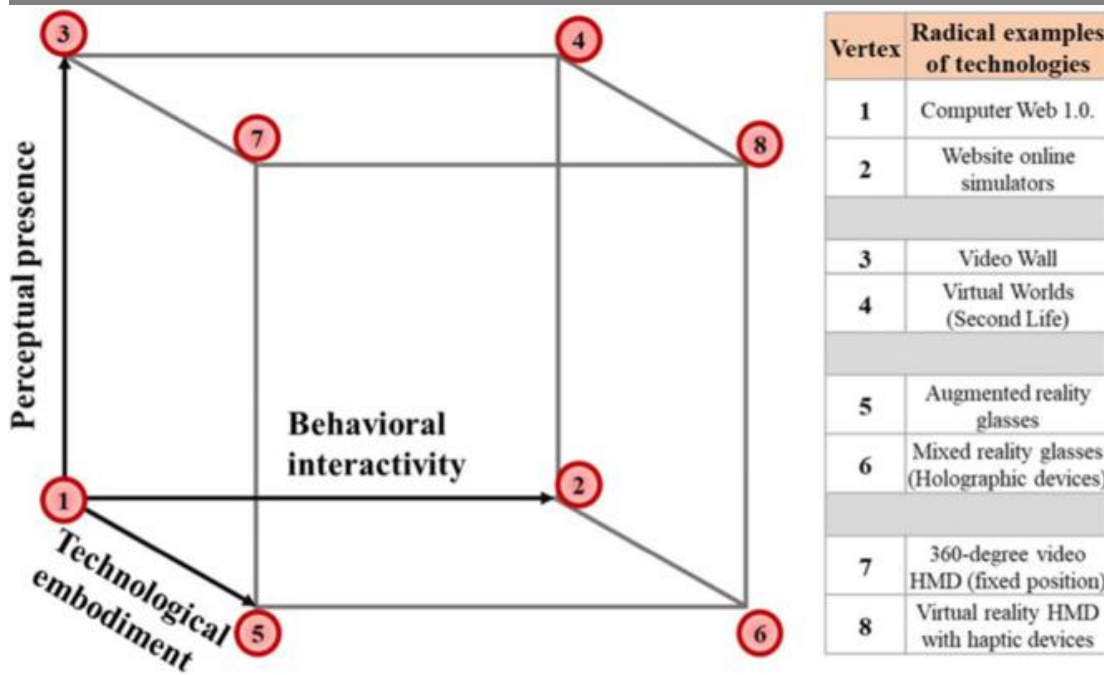


Figure 1. EPI Cube

Source: Flavián, C., Ibáñez-Sánchez, S., & Orús, C. (2019). The impact of virtual, augmented, and mixed reality technologies on the customer experience.

The following summary Table 1 summarizes key technological focus, sensory modalities, and main outcomes across the included studies for use in Scopus-style manuscript synthesis. These studies compare the core theories applied across the 26 studies, spanning frameworks such as Experiential Marketing, S–O–R, EPI Cube, and Telepresence. The table outlines how each framework has been operationalised within AR, VR, and multisensory settings, detailing the constructs, sensory cues, and experiential elements examined in previous work. It also clarifies how the present review builds on these foundations by adopting an AMO perspective and incorporating technology-embodiment reporting standards to support clearer comparisons and stronger theoretical coherence.

Author(s) & Year	Technology Type	Sensory Modalities	Key Findings
Alcañiz, Bigné & Guixeres (2019)	VR (framework/review)	Visual: mentions multisensory possibilities	Proposes a framework situating VR within marketing strategy; outlines research agenda.
Archer et al. (2022)	VR HMD + olfactory device	Visual, Auditory, Olfactory	Adding a congruent odour increases the sense of presence in VR.
Brengman, Willems & De Gauquier (2022)	VR ad experience	Visual, Auditory, Olfactory	Sound–scent congruence enhances engagement in multisensory VR ads.
Cornelio, Velasco & Obrist (2021)	Multisensory technologies	Multisensory (vision, audition, olfaction, haptics)	Reviews advances in multisensory integration technologies and implications.
Cowan et al. (2023)	VR with olfactory cues	Visual, Auditory, Olfactory	Olfactory cues in VR improve immersion and positive brand responses.
de Paiva Guimarães et al. (2022)	Olfactory display for VR glasses	Olfactory (device)	Introduces an attachable olfactory display for VR HMDs.
Du, Liu & Wang (2022)	AR marketing	Primarily visual; some multisensory discussion	Synthesizes AR marketing literature; proposes future research directions.
Erensoy et al. (2024)	VR retail environments	Multisensory (varies across studies)	Synthesizes consumer behavior in immersive VR retail via S–O–R.

Fiorentino et al. (2022)	In-store VR journey	Visual, Auditory, possible haptics	Multi-sensory VR supports the furniture retail customer journey.
Flavián, Ibáñez-Sánchez & Orús (2019)	VR, AR, MR	Primarily visual; multisensory potential	Impacts of VR/AR/MR on customer experience are mapped.
Flavián, Ibáñez-Sánchez & Orús (2021)	VR with scent manipulation	Visual, Auditory, Olfactory	Scent–content congruence enhances VR experience outcomes.
Fritz, Hadi & Stephen (2023)	Augmented Reality	Visual (AR)	AR presentation increases food desirability (‘from tablet to table’).
Kostyk & Bellman (2023)	VR in customer-centered marketing	Primarily visual; multisensory design noted	Guidelines for purpose-driven VR design in marketing.
Li, Seo & Chen (2023)	First-person VR with scent	Visual, Olfactory (habituation focus)	Habituation interacts with scent to shape VR responses.
Liu, Hannum & Simons (2019)	Immersive tech (likely VR CAVE or HMD)	Visual (context), possibly auditory; food tasting	Contextual congruence influences food evaluation in immersive settings.
Martin et al. (2021)	VR multimodality	Multimodal (visual, audio, haptics, olfactory)	Comprehensive survey on multimodality in VR.
Petit, Velasco & Spence (2019)	Digital sensory marketing	Multisensory (digital)	Integrates new technologies into multisensory online experiences.
Radianti et al. (2020)	Immersive VR in higher ed	Primarily visual/auditory; some multimodal	Synthesizes VR in higher education; provides a research agenda.
Rauschnabel et al. (2022)	XR (AR/VR umbrella)	Multimodal (varies)	Defines XR and proposes a framework for AR/VR.
Tewell & Ranasinghe (2024)	Olfactory display designs for VR	Olfactory (device designs)	Comprehensive review of olfactory displays for VR environments.
Wang, Minor et al. (2021)	VR for sensory & consumer science	Multisensory (applied to sensory science)	How to get started using VR in sensory/consumer research.
Wedel, Bigné & Zhang (2020)	VR & AR in consumer marketing	Primarily visual; acknowledges multisensory	Advances and future research in consumer marketing with VR/AR.
Xi & Hamari (2021)	VR shopping	Primarily visual; mentions multisensory factors	Synthesizes VR shopping literature; proposes an agenda.
Yildirim et al. (2024)	Immersive VR with multisensory stimuli	Visual, Auditory, Olfactory (built environment focus)	Evaluates responses to multisensory stimuli in immersive VR for built environments.
Zhang, Guo & Lee (2024)	Olfactory augmented VR towards the metaverse	Olfactory + other modalities (augmented VR)	Summarizes advances in olfactory augmented VR and applications.
Zulkarnain, Forde & Dodd (2024)	VR + scent identification	Visual, Olfactory (sensory)	Explores VR with scent identification for sensory analysis tasks.

Table 1. Summary of Technologies, Multisensory Modalities, and Primary Outcomes Reported in Reviewed Studies

METHODS

This systematic literature review was carried out using the Scopus and Web of Science databases. A set of keywords relating to sensory marketing, consumer experience, and immersive technologies guided the search strategy. To ensure relevance and quality, the inclusion criteria were defined as follows:

1. Articles published in English between 2014 and 2024.
2. Studies focusing on the influence of emerging technologies on customer experience through sensory modalities.
3. Peer-reviewed publications that met standards of academic rigor.
4. In total, 190 articles were identified and screened, of which 26 satisfied the inclusion criteria and were selected for qualitative synthesis.
5. The review process was structured in line with the PRISMA guidelines, with the corresponding flowchart used to illustrate the progression of records through the stages of identification, screening, eligibility, and final inclusion.

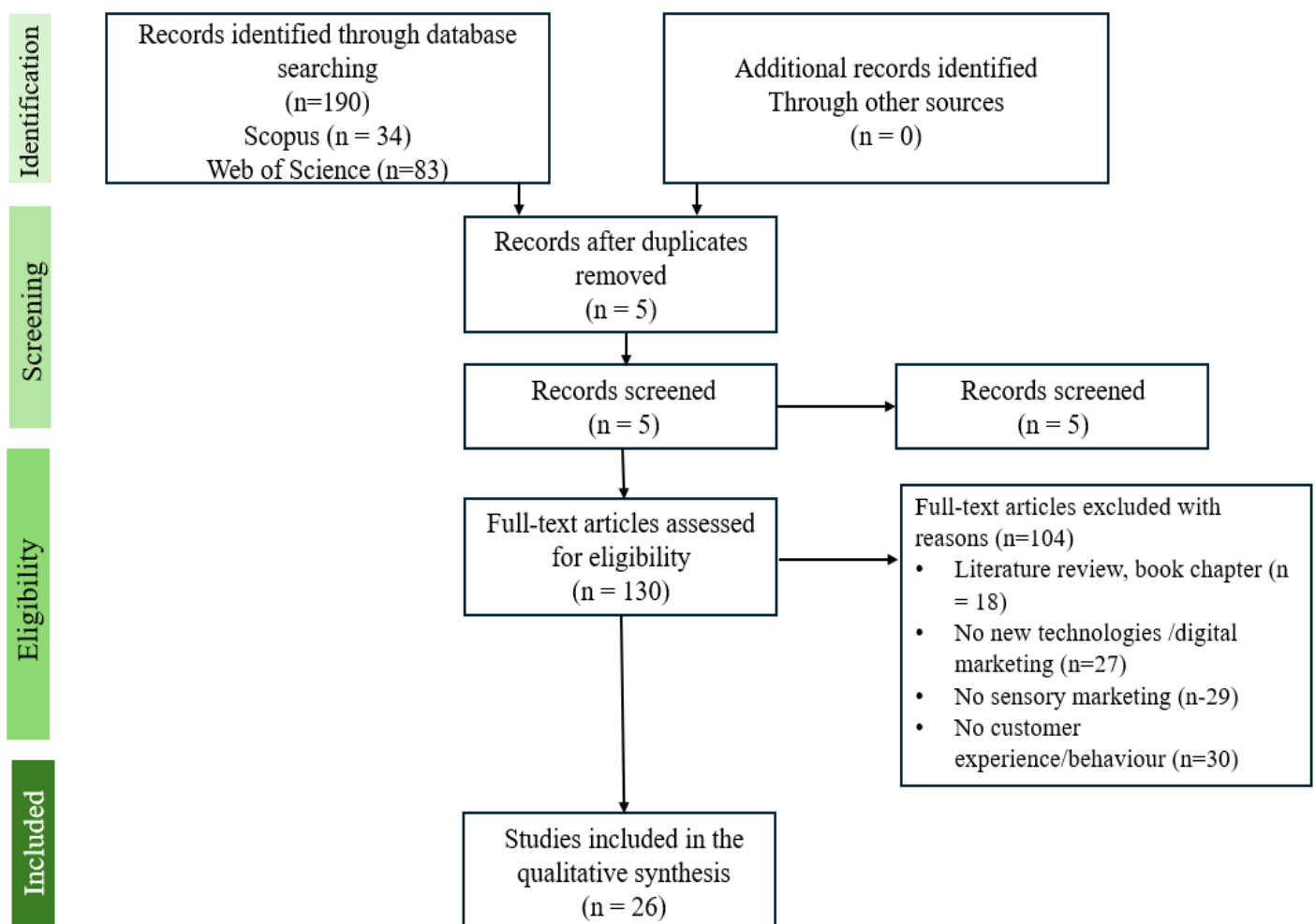


Figure 2. PRISMA Flowchart

Figure 2 presents the PRISMA flow chart that summarizes the study selection process. The database search across Scopus and Web of Science identified 190 records, and after removing duplicates, 130 full-text articles were assessed for eligibility. A total of 104 articles were excluded according to predefined criteria: literature reviews or book chapters ($n = 18$), studies without new technologies or digital marketing elements ($n = 27$), studies lacking a sensory marketing focus ($n = 29$), and studies without relevance to customer experience or behaviour ($n = 30$). In the end, 26 studies fulfilled all inclusion requirements and were included in the qualitative synthesis. This flow demonstrates a systematic and transparent approach to screening and selecting the studies.

RESULTS

The 26 studies included in the qualitative synthesis investigate how emerging sensory-enabling technologies, such as VR, AR, and immersive 3D environments, shape and influence customer experience. Based on these findings, a conceptual framework was developed to outline the key antecedents, moderators, mediators, and outcomes that commonly appear in research on technology-supported multisensory consumer experiences.

Table 2 reflects an overview of the journals where the 26 articles included in the systematic review were published. These were selected from Records identified through database searching (n=190) out of which Scopus (n = 34) and Web of Science (n=83). The availability of articles from different journals indicates the multidisciplinary nature and prevalence of emerging sensory-enabling technologies.

Journal Title	Number of Articles
Frontiers in Psychology	2
PLOS ONET	1
Journal of Personality and Social Psychology	1
Multimodal Technologies and Interaction	1
Journal of Retailing	1
Sensors	1
Journal of Consumer Behaviour	1
Future Internet	1
Journal of Business Research	1
Journal of the Academy of Marketing Science	1
Business Horizons	1
Scientific Reports	1
Food Research International	1
ACM Computing Surveys	2
Journal of Management	1
Journal of Interactive Marketing	1
Computers & Education	1
Computers in Human Behavior	1
Journal of Marketing Management	1
Food Quality and Preference	1
International Journal of Research in Marketing	1
SSRN (preprint)	1
Nature Communications	1
Frontiers in Virtual Reality	1

Table 2. Journal Title Table

Country Where the Studies were Conducted

The retrieved studies were conducted in different locations (see Table 3). The majority of the studies (n = 26) were conducted in multiple nations. Three studies were conducted in the United Kingdom, the United States, Spain, the Netherlands, Belgium, North America, Brazil, Poland, Singapore, Hungary, and Australia.

METHODOLOGY

Across the 26 studies reviewed, experimental designs constitute the largest share, representing approximately 40% of the total, reflecting the field's strong emphasis on empirical validation and applied behavioural testing. Review-based methodologies—including systematic literature reviews, narrative reviews, and scientific communication—account for roughly 25%, signalling growing efforts to consolidate and synthesise multisensory and immersive technology research. Conceptual and theoretical papers (including frameworks, research agendas, and conceptual-empirical hybrids) make up about 22%, highlighting the field's continued

need for model-building and theoretical grounding. The remaining 10–15% comprises field studies, engineering design studies, and practical guides, which indicate a smaller but important push toward real-world deployment and technology-driven design research. Together, these proportions show a balanced but empirically weighted research landscape, where experimental evidence leads, supported by conceptual development and systematic synthesis.

Authors	Country	Methodology
Alcañiz, Bigné & Guixeres (2019)	Zaragoza, Spain	Framework paper + research agenda
Archer et al. (2022)	London, United Kingdom	Experimental study
Brengman, Willems & De Gauquier (2022)	Brussel, Belgium.	Experimental study
Cornelio, Velasco & Obrist (2021)	Switzerland	Review paper
Cowan et al. (2023)	North America	Experimental study
de Paiva Guimarães et al. (2022)	Brazil	Engineering design study
Du, Liu & Wang (2022)	London, United Kingdom	Systematic literature review
Erensoy et al. (2024)	London, United Kingdom	Systematic literature review
Fiorentino et al. (2022)	London, United Kingdom	Field study
Flavián, Ibáñez-Sánchez & Orús (2019)	Zaragoza, Spain	Conceptual/theoretical paper
Flavián, Ibáñez-Sánchez & Orús (2021)	Zaragoza, Spain	Experimental study
Fritz, Hadi & Stephen (2023)	London, United Kingdom	Experimental study
Kacprzak (2017)	Poland	Conceptual (book)
Kostyk & Bellman (2023)	London, United Kingdom	Conceptual/theoretical paper
Li, Seo & Chen (2023)	Singapore	Experimental study
Liu, Hannum & Simons (2019)	United States of America	Experimental study
Mohammed, Ferzandi & Hamilton (2010)	United States of America	Review paper
Petit, Velasco & Spence (2019)	Netherlands	Conceptual + empirical discussion
Radiani et al. (2020)	Netherlands	Systematic literature review
Tewell & Ranasinghe (2024)	United States of America	Review paper
Wang, Minor et al. (2021)	London, United Kingdom	Practical guide + conceptual overview
Wedel, Bigné & Zhang (2020)	Netherlands	Conceptual + research agenda
Xi & Hamari (2021)	Netherlands	Literature review
Yildirim et al. (2024)	Sydney, Australia	Experimental study
Zhang, Guo & Lee (2024)	United States of America	Review/scientific communication
Zulkarnain, Forde & Dodd (2024)	Hungary	Experimental study

Table 3. Country Where Studies Were Conducted and Methodology

Conceptual Framework of Antecedents, Moderators, Mediators, and Outcomes

In this review, the articles were analysed using the antecedent–moderator–mediator–outcome model (Mohammed et al., 2010). Within this framework, antecedents refer to the initial conditions or input factors that shape subsequent outcomes. The links between these elements operate in two ways: mediators clarify the processes through which an effect unfolds, while moderators indicate when, for whom, or under what conditions.

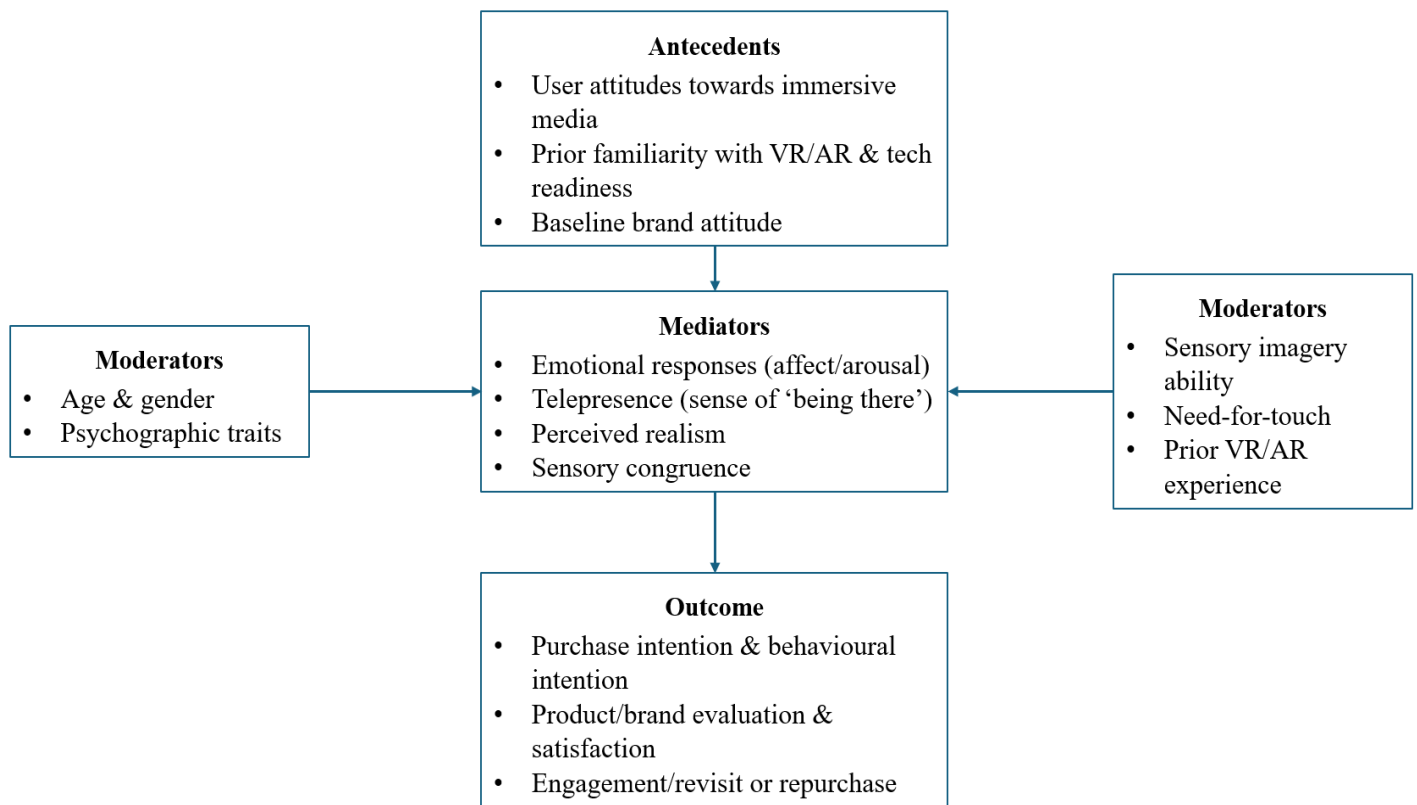


Figure 3. Conceptual framework – synthesis of antecedents, moderators, mediators, and outcomes

The conceptual framework shown in Figure 3 brings together the main elements that shape sensory-based customer experience in immersive environments. In this model, consumers' pre-existing beliefs, such as their attitudes toward immersive media, their familiarity with VR/AR, and their baseline perceptions of a brand, serve as antecedents that influence how they initially interpret and respond to sensory cues. These inputs move through key mediating processes, particularly emotional reactions and the sense of telepresence (the feeling of "being there"), which together determine how vivid, realistic, and meaningful the overall experience becomes.

Importantly, these pathways do not function uniformly across all consumers. The framework therefore includes moderators, such as age, gender, psychographic characteristics, sensory imagery ability, need for touch, and previous VR/AR experience, which can either heighten or lessen the impact of immersive cues on how consumers feel, process information, and respond.

Ultimately, these combined influences lead to a range of outcomes, reflected in consumer evaluations and behaviours such as purchase intention, brand satisfaction, engagement, and the likelihood of revisiting or repurchasing. The framework presents the consumer journey as a sequence: beginning with what consumers bring into the experience (antecedents), moving through the psychological processes that shape how they interpret sensory inputs (mediators), and culminating in the attitudes and behaviours that follow (outcomes). Moderators operate throughout this sequence, shaping the strength and direction of these relationships and explaining why immersive technologies affect brand engagement differently across individuals.

Sense of Telepresence

Telepresence emerges as a central construct, understood as the extent to which users feel present within a mediated environment. Higher levels of telepresence are consistently linked with stronger emotional engagement, greater trust, and increased purchase intentions. Research employing virtual reality (VR) settings highlights its pivotal role in enhancing perceptions of authenticity, deepening satisfaction, and fostering a sense of immersion. In this way, telepresence functions as a bridge between digital simulation and real-world perception, enabling consumers to experience mediated environments with a sense of realism that closely mirrors physical interactions.

Type of Technologies Studied

VR Goggles/Head-Mounted Display (HMD)

The intersection of immersive technology and sensory marketing has attracted growing scholarly interest in recent years, with particular focus on the application of virtual reality (VR) through head-mounted displays (HMDs). VR offers the capacity to recreate highly realistic environments while allowing marketers and researchers to exert precise control over sensory inputs. This makes it a valuable medium for examining and implementing multisensory integration within marketing contexts (Wang et al., 2021). Such developments resonate with Pine and Gilmore's (1999) experience economic framework, which emphasizes that richer, multi-sensory engagements strengthen the bond between consumers and brands.

A growing body of research highlights the role of olfactory cues in virtual reality (VR), particularly when combined with visual and auditory stimuli to create more immersive and persuasive brand experiences. Flavián, Ibáñez-Sánchez, and Orús (2021), for instance, investigated VR-based tourism pre-experiences and found that alignment between scent and visual content significantly enhanced sensory stimulation, emotional involvement, and behavioral intentions. Similar results have been reported in advertising research: Brengman, Willems, and De Gauquier (2022) demonstrated that congruence between scent and sound in VR advertisements strengthened customer engagement, heightened emotional resonance, and improved attentional focus. Extending these insights to retail contexts, Cowan et al. (2023) showed that integrating olfactory cues into VR shopping environments deepened immersion and fostered flow states, which in turn led to more favorable brand evaluations. Together, these studies underscore the unique potential of scent to enrich multisensory experiences and amplify the effectiveness of VR-based marketing strategies.

In the food and beverage (F&B) sector, virtual reality (VR) opens new possibilities for recreating contextual consumption settings that shape how products are experienced. Liu, Hannum, and Simons (2019) employed head-mounted displays (HMDs) to design a virtual café, where participants tasted coffee while exposed to either congruent or incongruent auditory and olfactory cues. Their study showed that when the sensory cues were aligned, participants reported greater product liking, made faster decisions, and formed more positive overall perceptions of the coffee. These findings highlight the critical role of sensory congruence in shaping consumer responses and underscore the relevance of VR for the F&B industry, where product evaluation is closely linked to ambience, atmosphere, and multi-sensory context.

Outside the laboratory, virtual reality (VR) has been increasingly tested in real retail settings to understand how multi-sensory stimuli shape the shopping experience. Fiorentino et al. (2022) introduced a VR journey in a flagship furniture store, where visual, auditory, and tactile cues delivered through head-mounted displays (HMDs) were combined to create an immersive in-store experience. Their findings showed that this multi-sensory integration not only deepened customer engagement but also improved brand recall and boosted purchase intention. In a broader perspective, Xi and Hamari's (2021) systematic review of VR shopping confirmed that multi-sensory immersion is a crucial factor in enhancing perceived realism and enjoyment, underlining its role as a key driver in the evolution of virtual retail environments.

The literature highlights the presence as the psychological sense of "being there", as a key mechanism underpinning sensory-augmented VR experiences. Archer et al. (2022) demonstrated that incorporating scent into head-mounted display (HMD) environments significantly strengthened users' sense of presence, indicating that olfactory integration exerts both cognitive and emotional influence. This finding aligns with recent technological innovations, such as the olfactory display for VR glasses introduced by de Paiva Guimarães et al. (2022), which enables precise and targeted scent delivery within immersive settings. Together, these advances illustrate how scent-based technologies not only enhance realism but also provide researchers and marketers with new opportunities to design controlled, replicable multi-sensory experiments.

From a strategic perspective, Kostyk and Bellman (2023) emphasize that virtual reality (VR) experiences, especially those incorporating multiple sensory elements, should be purpose-driven, carefully aligned with brand positioning and consumer expectations. This view is reinforced by Zulkarnain et al. (2024), who demonstrated the use of scent identification tasks in VR as an innovative tool for sensory analysis and product

testing, giving brands new opportunities for market research and product development. Adding another layer of insight, Li et al. (2023) examined how habituation shapes the perception of scent in VR, highlighting the importance of exposure duration and its implications for sustaining long-term brand experiences.

Taken together, these studies show that head-mounted display virtual reality (HMD-VR) extends far beyond its role as a visual novelty. It is emerging as a powerful platform for creating controlled, multi-sensory experiences that shape consumer emotions, cognitive judgments, and behavioral intentions. Within the food and beverage (F&B) sector, VR offers particularly valuable opportunities by enabling the replication and manipulation of both environmental and product-related cues. This capacity allows researchers and practitioners to test, refine, and scale sensory marketing strategies across physical settings and digital touchpoints, bridging the gap between experimental design and real-world application.

3D Virtual Environments

In recent years, studies on three-dimensional virtual environments (VEs), including virtual reality (VR), augmented reality (AR), and mixed reality (XR), have increasingly converged with sensory marketing. Alcañiz, Bigné, and Guixeres (2019) laid important groundwork by proposing a conceptual framework that situates VR within marketing practice, outlining its potential to enrich consumer experiences and setting out a research agenda for future exploration. Building on this foundation, Rauschnabel et al. (2022) and Wedel, Bigné, and Zhang (2020) broaden the theoretical lens, demonstrating how XR technologies can be systematically embedded into consumer marketing strategies. Together, these contributions provide a critical basis for understanding how sensory marketing can be positioned within the expanding landscape of immersive media.

From a consumer behaviour perspective, systematic reviews such as Erensoy et al. (2024) bring together evidence on the ways immersive VR retail environments shape shopper responses. Using the **Stimulus–Organism–Response (S–O–R)** model as a guiding framework, their analysis highlights the importance of sensory and spatial cues as key drivers of engagement, purchase intention, and customer satisfaction in virtual retail contexts. These insights align closely with the central aims of sensory marketing, which seeks to activate multiple senses in order to influence brand perceptions and guide consumer behaviour.

An expanding body of empirical research has begun to examine how multisensory integration operates within virtual reality (VR), with particular attention to the role of olfactory cues in shaping immersion and consumer responses. Brengman, Willems, and De Gauquier (2022) demonstrate that congruence between scent and sound in VR advertising enhances user engagement, while Cowan et al. (2023) show that incorporating smell into virtual environments strengthens positive brand associations. Similarly, Flavián, Ibáñez-Sánchez, and Orús (2021) find that aligning aroma with visual content heightens emotional reactions and increases perceptions of realism. Taken together, these studies underscore olfaction as a powerful yet still underutilized sensory dimension within VR-based marketing strategies.

Challenges surrounding the design and implementation of olfactory VR systems have been outlined in the review by Tewell and Ranasinghe (2024), which categorizes the main technical approaches used for delivering scents through head-mounted displays. Their work is complemented by broader discussions of digital sensory marketing, such as the overview provided by Petit, Velasco, and Spence (2019), who examine how emerging technologies are increasingly able to integrate touch, taste, smell, and sound into digital brand experiences. Together, these contributions highlight both the technological hurdles and the expanding opportunities for embedding multi-sensory elements into immersive marketing environments.

Beyond studies that focus directly on marketing, several cross-disciplinary reviews provide valuable methodological insights for advancing sensory marketing research. Martin et al. (2021) deliver a comprehensive survey of multimodality in VR, addressing hardware, software, and perceptual considerations that shape user experience. Radianti et al. (2020), examining immersive VR in educational contexts, extract design lessons that can be applied to the creation of experiential marketing environments. In a similar vein, Cornelio et al. (2021) discuss recent technological advances in multisensory integration, offering theoretical foundations that support the design of multi-cue virtual environments. Collectively, these contributions extend

the methodological toolkit available to sensory marketing scholars, bridging technical innovation with applied consumer research.

Recent applied research has also begun to examine the practical challenges of combining olfactory and other sensory cues within virtual reality (VR). For example, Yildirim et al. (2024) investigated how multi-sensory integration in VR can shape human responses in built environments. Although their study is rooted in architectural and environmental design, the insights carry clear implications for fields such as retail, hospitality, and brand experience, where atmosphere and sensory engagement are central to consumer perception and behavior.

Taken together, these studies provide a robust foundation for a systematic review of three-dimensional virtual environments (VEs) in the context of sensory marketing. The body of work spans **conceptual models, empirical findings, enabling technologies, and methodological insights**, illustrating the breadth and depth of current scholarship. What emerges is a clear picture of sensory marketing in VEs as an inherently interdisciplinary field, drawing on perspectives from marketing, human–computer interaction, cognitive psychology, and sensory science. At the same time, the literature reveals persistent gaps, particularly around standardization, measurement, and the design of cross-modal experiences, that future research must address in order to advance both theoretical development and practical application.

AR-Based Solutions

AR as a Framework for Multisensory Marketing

Recent systematic reviews have shown that augmented reality (AR) has evolved from being a novelty to becoming a powerful driver of immersive marketing experiences. Du, Liu, and Wang (2022) provide a comprehensive mapping of AR marketing, identifying its distinctive strengths in connecting physical and digital touchpoints. Their review underscores the importance of presence, interactivity, and personalization, three factors that are central to effective sensory marketing. At the same time, they point to a significant gap: the limited integration of multisensory elements such as touch, sound, and scent, which leaves most AR applications still heavily reliant on visual stimuli. Addressing this gap opens the door for future research to position AR as a catalyst for holistic brand experiences, better aligned with consumer expectations in what has increasingly been described as the “age of experience.”

AR × Multisensory Integration in Consumer Experiences

Empirical research demonstrates that augmented reality (AR) has the capacity to stimulate multisensory imagination and reshape consumer perceptions of products, particularly within food-related contexts. Fritz et al. (2023) showed that AR can heighten food desirability through mental simulation, whereby digital overlays trigger vivid sensory associations such as taste, texture, and even aroma. Their findings reveal that AR influences not only cognitive evaluations but also emotional responses, ultimately reinforcing purchase intentions and deepening brand attachment. These insights suggest that AR operates as a bridge between sensory perception and consumer decision-making, extending the literature on multisensory integration by providing a scalable digital pathway for sensory-rich marketing strategies.

Multisensory Technologies Enabling AR Expansion

Recent advances in sensory technologies are pushing augmented reality (AR) beyond visual augmentation into the realms of olfaction and haptics, opening new possibilities for sensory marketing. Zhang et al. (2024) review developments in olfactory-AR systems, showing how controlled scent diffusion can be synchronized with digital content to heighten immersion and elicit stronger emotional responses. Their findings highlight the ability of olfactory cues, when embedded in AR environments, to enhance presence and support memory encoding, both of which are central to building lasting consumer–brand relationships. The convergence of AR with olfactory and haptic technologies therefore marks not only an important technological milestone but also a significant opportunity for marketing scholars to design and evaluate multisensory experiences that capture the richness of real-world encounters within digital commerce.

Current Limitations

Type of Technology

Despite rapid advances in head-mounted display (HMD) research within sensory marketing, several important gaps remain. First, most studies have examined outcomes under tightly controlled and fully congruent sensory cue conditions, leaving boundary situations underexplored, for instance, how incongruence, cue competition, or temporal asynchronies among scent, sound, and visual stimuli influence psychological responses such as presence, flow, or persuasion (Flavián et al., 2021; Brengman et al., 2022; Cowan et al., 2023). Second, olfactory delivery technologies lack standardization: existing hardware differs considerably in latency, intensity regulation, refill chemistry, and placement, which complicates replication and cross-study comparison (de Paiva Guimarães et al., 2022; Tewell & Ranasinghe, 2024). Third, much of the evidence is derived from brief, single-exposure experiments relying primarily on self-report measures; longitudinal designs that capture habituation, carryover, or learning effects, and that integrate psychophysiological or behavioral data with survey responses, remain scarce (Li et al., 2023; Wang et al., 2021). Finally, external validity is uneven: while some field studies have emerged, they are often limited in scope and sector diversity, and participant samples tend to underrepresent older adults, individuals with olfactory impairments, and culturally diverse populations that are central to global retail and food-and-beverage contexts (Fiorentino et al., 2022; Xi & Hamari, 2021).

Future research should move beyond “demo-grade” immersion toward generating decision-relevant evidence. This entails preregistered, multi-site experiments that benchmark HMD-based virtual reality (VR) against robust alternatives such as desktop 3D, mobile video, or augmented reality, in order to quantify the incremental impact of multisensory VR on key performance indicators including willingness to pay, basket composition, and repeat purchase intention (Wedel et al., 2020; Xi & Hamari, 2021). To enhance reproducibility, the field also requires standardized reporting for olfactory technologies, covering parameters such as airflow rates, delivery latency, and concentration, as well as shared stimulus repositories and open experimental protocols (Tewell & Ranasinghe, 2024). Furthermore, mediation models that examine presence, affect, and memory as explanatory mechanisms, ideally supported by biometric or behavioral telemetry, are needed to clarify when and how multisensory HMD experiences translate into brand-relevant outcomes (Archer et al., 2022; Cowan et al., 2023). Finally, purpose-driven study designs that align immersive experiences with brand strategy and context (e.g., pre-experience engagement, product assortment testing, or service recovery) can help bridge laboratory findings and real-world applications, enabling scalable and ethically grounded deployments (Kostyk & Bellman, 2023; Wang et al., 2021).

Characteristics of Technology

Despite encouraging findings, research on head-mounted display virtual reality (HMD-VR) in sensory marketing still faces several technology-driven limitations that constrain cumulative progress. Olfactory delivery remains poorly standardized across devices, varying in nozzle placement, flow rate, latency, and concentration control—which complicates replication and hinders reliable effect-size synthesis (de Paiva Guimarães et al., 2022; Tewell & Ranasinghe, 2024). Most experiments are optimized for congruent sensory cues, leaving limited understanding of how incongruence, cue competition, or temporal asynchrony among stimuli influence presence, affect, and persuasion (Flavián et al., 2021; Brengman et al., 2022). Measurement practices are also narrow: presence and emotion are typically captured through short, self-reported exposures, with few longitudinal designs exploring habituation or learning effects over time (Archer et al., 2022; Li et al., 2023). Moreover, generalizability beyond controlled laboratory contexts remains underexamined existing field studies are small in scale, platform-specific, and confined to a limited set of industries and participant profiles (Fiorentino et al., 2022; Xi & Hamari, 2021).

In the domains of 3D virtual environments and augmented reality (AR), characteristic technological constraints continue to produce notable blind spots. Although reviews highlight the broad potential of AR for sensory engagement, current implementations remain predominantly visual, with few rigorously controlled integrations of scent or haptic cues and limited reporting of device-level parameters (Du et al., 2022; Petit et al., 2019). Emerging olfactory-AR systems show considerable promise but still lack validated protocols for synchronization, intensity calibration, and battery-safe operation in applied contexts (Zhang et al., 2024).

Comparative studies that quantify the incremental value of AR or VR relative to robust baselines, such as mobile video or desktop 3D, on decision-relevant key performance indicators remain rare, as do open stimulus repositories and preregistered, multi-site experimental designs (Wedel et al., 2020; Martin et al., 2021). Moreover, the alignment between technological capabilities and strategic brand objectives is often underspecified; future work should articulate how multisensory systems can be designed to meet brand goals and user expectations while promoting accessibility, inclusivity, and ethical deployment at scale (Kostyk & Bellman, 2023; Radianti et al., 2020).

Customer Characteristics

Customer-level heterogeneity remains underexplored in multisensory HMD-VR research. Participant samples are typically young and technologically proficient, with limited assessment of individual traits that may moderate experiential and persuasive outcomes, such as olfactory acuity (including hyposmia or anosmia), sensory imagery ability, need for touch, prior VR exposure, and susceptibility to cybersickness (Wang et al., 2021; Xi & Hamari, 2021; Martin et al., 2021; Archer et al., 2022). This narrow profiling constrains the generalizability of observed effects on presence, flow, and persuasion. Moreover, few studies model habituation or learning processes over time, despite evidence that repeated exposure influences scent perception and subsequent brand evaluations (Li et al., 2023). Incorporating standardized screening and reporting practices, for instance, odor threshold tests or documented VR use history, and recruiting participants across broader age ranges and sensory ability levels would enhance external validity and improve the interpretability of multisensory effects (Peck & Wiggins, 2006; Kim et al., 2021).

Across 3D virtual environments and augmented reality (AR), customer characteristics such as cultural scent associations, baseline brand relationship strength, and privacy–trust orientations remain insufficiently theorized as moderators of multisensory effects (Petit et al., 2019; Du et al., 2022). Few studies explicitly segment participants along these dimensions or benchmark results against robust non-immersive baselines, limiting understanding of for whom and under what conditions AR or VR interventions are most effective (Radianti et al., 2020; Wedel et al., 2020). Existing evidence indicates that mental simulation and affective responses vary significantly across individuals and contexts, yet cross-cultural, multi-site field studies and purpose-driven segmentation frameworks are still rare (Fritz et al., 2023; Kostyk & Bellman, 2023). Furthermore, variations in ethical acceptance and data-sensitivity, particularly regarding comfort with biometric or affective data capture—require systematic investigation to guide inclusive and socially responsible applications of multisensory technologies at scale (Spence, 2020).

Marketing Effects

Evidence on the marketing impact of multisensory head-mounted display virtual reality (HMD-VR) is encouraging but remains incomplete. While numerous studies report gains in presence, emotional engagement, and experiential immersion, few trace these effects to concrete behavioral outcomes such as product choice, willingness to pay, basket size, repeat purchase intention, or sales uplift, and most omit robust comparison conditions such as desktop 3D or mobile video (Flavián et al., 2021; Brengman et al., 2022; Cowan et al., 2023; Wedel et al., 2020). Experimental designs are often short-term, laboratory-based, and reliant on self-reported measures; longitudinal and field-based evidence linking experiential mediators—such as presence and flow, to enduring brand equity and behavioral metrics remains scarce, particularly in the context of repeated or scent-based exposures (Archer et al., 2022; Li et al., 2023; Wang et al., 2021). Although early retail implementations demonstrate engagement benefits, large-scale, multi-category demonstrations of incremental effects on conversion, loyalty, and revenue are still limited (Fiorentino et al., 2022; Xi & Hamari, 2021).

Across 3D virtual environments and augmented reality (AR), current research outlines substantial potential but provides limited clarity on when and for whom multisensory experiences generate economically meaningful value. Most AR studies remain predominantly visual, offering limited causal evidence that the addition of scent or haptic elements enhances persuasion, memory, or cross-channel effects beyond aesthetic novelty. Moreover, device-level reporting remains inconsistent, making it difficult to compare sensory effects across platforms and studies (Du et al., 2022; Petit et al., 2019; Tewell & Ranasinghe, 2024). The alignment between sensory design and strategic marketing objectives also remains underexplored. Few preregistered, multi-site A/B experiments

explicitly connect sensory configurations to brand goals or quantify return on investment relative to conventional touchpoints. Likewise, emerging standards for olfactory synchronization, intensity calibration, and real-world deployment in AR/VR campaigns are still nascent and incomplete (Kostyk & Bellman, 2023; Alcañiz et al., 2019; Zhang et al., 2024; Radianti et al., 2020).

Markets Investigated

Research on multisensory head-mounted display virtual reality (HMD-VR) remains concentrated within a narrow set of market contexts, such as tourism pre-experiences, laboratory-based food and beverage tastings, flagship retail trials, and advertising, limiting the generalizability of findings to broader service and business-to-business environments (Flavián et al., 2021; Liu et al., 2019; Fiorentino et al., 2022; Brengman et al., 2022). Evidence of brand-related gains largely originates from these specialized domains or from meta-analyses of “VR shopping,” leaving significant gaps in high-frequency, price-sensitive categories such as grocery and quick-service restaurants, as well as in operational sectors like hospitality and transportation where scent and spatial dynamics jointly shape the customer experience (Cowan et al., 2023; Xi & Hamari, 2021). Cross-market comparisons are similarly limited: most studies rely on WEIRD samples and single-country pilots, providing little understanding of how cultural norms around scent, retail layout, or regulatory conditions may moderate multisensory effects.

Across 3D virtual environments and augmented reality (AR), the literature remains weighted toward conceptual frameworks and review articles rather than market-diverse field implementations. Existing AR research is still largely visual in focus, with few real-world commercial applications that engage multiple sensory modalities (Alcañiz et al., 2019; Wedel et al., 2020; Du et al., 2022). Prototype olfactory systems demonstrate potential but have yet to undergo scaled, cross-cultural validation in live retail or hospitality contexts, where synchronization accuracy, safety, and regulatory compliance are essential for practical adoption (Tewell & Ranasinghe, 2024; Zhang et al., 2024; Yildirim et al., 2024). Future research should prioritize multi-site A/B experiments across regions and industry sectors, directly benchmarking AR and VR experiences against established marketing touchpoints to quantify their incremental effects on conversion, loyalty, and customer lifetime value.

CONCLUSION

This review is subject to several limitations that should be considered when interpreting its findings. Current empirical work remains strongly centred on visually driven studies, with limited integration of olfactory and haptic modalities and inconsistent reporting of essential device characteristics such as latency, stimulus intensity, and delivery mechanisms. These omissions constrain methodological transparency and reduce the comparability of results across studies. Furthermore, much of the evidence is derived from short, single-exposure laboratory experiments that rely heavily on self-reported outcomes, offering only a partial view of how multisensory experiences develop over time or translate into behavioural and physiological responses.

The generalisability of existing research is also limited by narrow and relatively homogenous sampling frames, which tend to overrepresent young, technologically familiar, and culturally similar participants. Finally, the exclusion of non-English publications, grey literature, and industry-based work may introduce publication and language bias, shaping the scope of insights that can be drawn from this review. Taken together, these limitations point to several important avenues for future research. Greater methodological consistency is needed, particularly in documenting sensory technologies with sufficient detail to support replication and cross-study synthesis. Longitudinal and mixed-method designs would help illuminate how repeated or prolonged exposure to multisensory environments influences learning, memory, decision-making, and behavioural outcomes.

Further work is also required to examine boundary conditions—including sensory incongruence, cue competition, and timing effects—to clarify the circumstances under which immersive technologies strengthen or weaken user responses. Broader and more diverse participant samples are essential to capture variation in age, sensory acuity, cultural associations, and prior experience with immersive media. In addition, comparative

studies that benchmark immersive experiences against realistic alternatives such as desktop 3D or mobile video would provide a clearer understanding of their incremental value for key marketing indicators.

Finally, expanding research across underrepresented sectors, including hospitality, transportation, service operations, and high-frequency retail environments, will help establish a more comprehensive evidence base that better reflects the range of contexts in which multisensory technologies may be applied.

FUTURE RESEARCH

Future research should move beyond the current predominance of visually oriented, short-term laboratory studies to more comprehensively examine multisensory integration within immersive technologies. In particular, greater attention is warranted for non-visual modalities, especially olfactory and haptic cues, which remain comparatively underexplored despite their potential to shape consumer experience. Although existing studies suggest that congruent multisensory stimuli enhance telepresence, affective responses, and engagement, limited insight is available regarding the boundary conditions of these effects. Critical issues such as sensory incongruence, cue competition, and temporal asynchrony have received scant empirical attention, even though they may meaningfully disrupt or attenuate immersive experiences.

Methodologically, much of the literature relies on single-exposure designs and self-reported outcomes, constraining understanding of how multisensory effects evolve over time. Longitudinal and mixed-method approaches that integrate behavioural indicators alongside biometric and psychophysiological measures would allow researchers to examine habituation processes, learning effects, and the durability of multisensory influence. Greater methodological standardisation is also needed, particularly through transparent reporting of device-specific parameters such as scent delivery latency, intensity, diffusion method, and spatial placement. Such precision would enhance replicability and support cumulative theory development in multisensory and immersive experience research.

Beyond internal validity, future inquiry should more explicitly address user heterogeneity and market relevance in order to strengthen external validity and managerial usefulness. Individual differences, including sensory sensitivity, prior experience with VR or AR technologies, age, and culturally embedded scent associations, remain insufficiently theorised as moderators of multisensory effects. Accounting for such variation is essential for explaining heterogeneous user responses and for translating experimental findings into actionable insights for practitioners.

In addition, cross-cultural and multi-site field studies are particularly needed to assess how immersive multisensory experiences perform across applied contexts, including hospitality, food and beverage, retail, and service industries. Importantly, future research should establish clearer links between experiential mediators, such as telepresence and emotional engagement, and decision-relevant marketing outcomes, including willingness to pay, repeat purchase intention, customer loyalty, and return on investment. Immersive formats should also be systematically benchmarked against credible non-immersive alternatives, such as desktop-based 3D environments or mobile video, to determine the conditions under which multisensory immersion delivers meaningful incremental value. Collectively, such work would clarify when immersive multisensory technologies are most effective and how they may be deployed ethically, strategically, and at scale.

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