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Immersive Art Exhibitions: Sensory Intensity Effects on Visitor Satisfaction via Visitor Attention and Visitor Experience

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ABSTRACT

The rise of multisensory-immersive technology has transformed visitor experiences in museums, yet a notable gap remains in distinguishing between immersive and traditional exhibitions. This study examines the added value of immersive exhibitions over traditional formats, specifically how sensory intensity influences experiential satisfaction. A survey of 356 participants who visited either a digital immersive exhibition rich in visual and auditory stimuli or a traditional art museum exhibition with limited sensory inputs (mainly by eyes) reveals that immersive experiences significantly enhance attention, experience, and overall satisfaction. The findings also suggest that visitor attention is a valuable extension to the *experience economy* model, with esthetic, entertainment, and escapism dimensions substantially contributing to satisfaction. The study highlights the importance of integrating sensory inputs to capture visitor attention, thereby extending the *experience economy* framework through an exploration of cause-and-effect relationships. Practical implications for museum management are discussed, offering insights for optimizing visitor engagement.

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Introduction

The evolving landscape of curatorship, particularly the shift from object-centered exhibitions to embodied spectatorship and the integration of sensory-immersive technologies has catalyzed the growth of immersive exhibitions, gaining traction in academia and museums. Unlike *traditional exhibitions*, which prioritize objective authenticity and emphasize visual engagement with physical artworks, *immersive exhibitions* are grounded in the concept of existential authenticity. They employ multisensory environments and digital artworks to enrich visitor experiences, with a particular emphasis on auditory and visual engagement. For example, "Van Gogh—The Immersive Experience" employs large-scale projections, 360° visuals, and synchronized sounds to transcend time and space. This evolution reflects the sensory turn in museology, which has shifted museums from sites of object-centered spectatorship—primarily focused

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on visual engagement—to deeper experiential involvement in auditory and visual immersion (Howes, 2014). With advances in sensory-immersive technologies, sensory museology has emerged as a revolutionary paradigm, positioning the senses as integral to exhibition design (Crouch & Damjanov, 2021; Kjellmer, 2021; Pine & Gilmore, 1999). However, key questions remain: Do visitors react differently to traditional versus immersive exhibitions? What mechanisms drive reactions to heightened sensory experiences?

Despite growing interest, limited field studies have directly compared traditional and immersive exhibitions, especially in distinct overall sensory environments. Most existing research examines isolated sensory cues in controlled settings (e.g., Krishna et al., 2010; Novak et al., 2020; Sweetman et al., 2020), providing insights into specific sensory impacts but overlooking the broader exhibition atmosphere. Yet, the ambient environment significantly influences visitor satisfaction. During actual visits, experiences unfold continuously across interconnected spaces, involving multiple exhibits within a cohesive sensory context. Addressing this gap, the present study employs a field approach to compare visitor reactions to two exhibition types—traditional and immersive—both showcasing Flemish arts. The selected *traditional exhibition* in the present study, centered on objective authenticity, presents physical Flemish paintings, emphasizing visual engagement. In contrast, the *immersive exhibition*, grounded in existential authenticity, features digital renderings of paintings and integrates 360° projections and first-person narratives to create a multisensory experience. This study compares the object-centered approach of the traditional exhibition with the experience-centered approach of the immersive exhibition, which emphasizes both auditory and visual engagement. Rather than isolating individual sensory modalities, the study considers the overall sensory environment within each exhibition type, providing a holistic perspective on how these distinct sensory settings shape visitor experiences.

Immersive exhibitions have the potential to amplify sensory intensity, primarily through visual and auditory stimuli, which are anticipated to shape visitor attention and enhance experiential value. Crouch and Damjanov (2021) emphasized that highly multisensory environments—particularly those involving "extreme VR"—significantly elevate emotional immersion and foster deeper visitor engagement. Similarly, Rudi's (2021) empirical study on soundscape design within an architectural museum context demonstrated that auditory elements contribute substantially to visitors' perceptions of authenticity and credibility in immersive settings, thereby intensifying their sense of "realness." These findings prompt broader considerations regarding the role of auditory cues in blurring the boundaries between physical and virtual or digital realities.

Visitors may also engage with the four realms of experience—esthetics, education, entertainment, and escapism—proposed by Pine and Gilmore (1999). Originally from the *experience economy* framework, which emphasizes service-oriented, memorable experiences, this well-established model is widely applied in museum studies. The four experience realms provide a comprehensive framework for analyzing visitor experiences, particularly in sensory-rich environments. These dimensions vary in relevance depending on the context, with education dominating museum settings and escapism playing a key role in festivals (Mehmetoglu & Engen, 2011). Experiential values, in turn, significantly predict visitor satisfaction (Ali et al., 2016). Together, perceived sensory intensity, attention, and experiential values likely shape

satisfaction, with immersive exhibitions potentially fostering more positive reactions than traditional ones.

Therefore, this study extends prior research by investigating the effects of exhibition type on visitors' sensory experiences and satisfaction. Drawing on Mehrabian and Russell (1974) Stimulus–Organism–Response (SOR) model and Pine and Gilmore's experiential framework (i.e., esthetics, education, entertainment, and escapism), it examines how sensory intensity (S) influences satisfaction (R) through attention and experience dimensions (O). Satisfaction, a reliable measure of objective effectiveness and subjective perceptions, serves as the dependent variable (Jeong & Lee, 2006; Zhang et al., 2021). The findings aim to advance the understanding of sensory mechanisms in exhibition design and provide insights for optimizing visitor experiences.

Theoretical background

Multisensory cues in exhibition design

The literature robustly supports the influence of sensory cues on visitors' emotional, cognitive, and behavioral responses (see reviews: Agapito, 2020; Elder & Krishna, 2022; Luo et al., 2024). The concept of "sensory museology" (Howes, 2014; Howes et al., 2018) underscored a notable shift toward multisensory engagement within museums, offering fresh insights into the profound impact on visitor experience. A comprehensive review of empirical studies on the influence of multisensory cues on visitor reactions is presented in Supplementary Appendix A.

Nevertheless, interactions between visitors and exhibitions are inherently complex, dynamic, and multi-layered. Sensory cues operate as components of museum atmospherics, integrated within the physical environment of the museum. According to Falk and Dierking (2018) Contextual Learning Model, visitors' learning experiences emerge from the intersection of physical, sociocultural, and personal contexts. This interactive process is shaped by a myriad of factors, both external and internal, that influence the visitor-exhibition experience (Falk & Dierking, 2018; Leder & Nadal, 2014; Pelowski et al., 2017). The nature of this interaction adheres to both bottom-up and top-down processing pathways (see reviews: Talsma et al., 2010; Noppeney, 2021), signifying a dynamic interplay between environmental stimuli and the visitor's cognitive processes. Bottom-up processing elicits automatic responses to sensory stimuli present in the museum environment, while top-down processing entails more deliberate, cognitive interpretations by the visitor. This interplay between visitors and exhibitions presents unique challenges for museum management, as it heavily depends on visitors' characteristics and situational factors. Key elements include visitors' mental imagery, the congruency of semantic associations across sensory modalities, and the vividness of imagery evoked by multisensory cues, all of which can impact cognitive engagement and attentional control. Moreover, congruency within sensory cues and the physical environment can facilitate effective communication and knowledge transfer. However, incongruent sensory settings may also stimulate positive reactions in visitors, as studies have indicated that mismatched sensory stimuli, such as incongruent scents and artworks, can increase arousal (Cirrincione et al., 2014).

Notably, sensory cues as elements of museum atmospherics have garnered significant attention in exhibition design, where they serve strategic roles in shaping practical, esthetic, and sensory environments for visitors (Kotler et al., 2008). Common strategies for creating multisensory experiences include: (1) multisensory offerings, which involve stimulating senses beyond vision within a single exhibition context (e.g., Pursey & Lomas, 2018); (2) synesthesia, which aims to evoke involuntary cross-modal sensory associations, thereby enriching the visitor's perceptual experience (e.g., Merter, 2017; Whitelaw, 2008); and (3) leveraging new technologies to enhance multisensory representation through mediums such as mixed reality (MR), virtual reality (VR), augmented reality (AR), mobile applications, and 3D techniques (Crouch & Damjanov, 2021).

The evolving landscape of curatorship

With the increasing emphasis on experiential perceptions and the rise of immersive technologies—such as video mapping, augmented reality (AR), and virtual reality (VR)—a fundamental shift in curatorial practices is occurring in museum contexts. This shift marks a transition from object-centered curation toward experience- or visitor-centered curation. Prior research highlighted the emergence of affective (Varutti, 2023), intentional (Villeneuve et al., 2021), and collaborative curatorship (Stuedahl et al., 2021), reflecting a broader transformation in the conceptualization of museum engagement. These developments necessitate critical inquiries into knowledge production and dissemination within public museums, particularly concerning the dynamic interrelationship between visitors, exhibition displays, and museums. Concepts such as the "embodied gaze," "decentralization," and "immersion" have gained attention (Christidou & Diamantopoulou, 2016; Christidou & Pierroux, 2019; Kryklywy et al., 2020), contributing to epistemological discussions that traverse the dualism of traditional and immersive paradigms, objects, and experiences, as well as objective and existential authenticity.

Spectatorship: from object-centered to embodied

Traditional exhibitions are predominantly object-centered, adhering to curatorial principles that emphasize material authenticity and the originality of artworks. Such exhibitions typically involve limited sensory engagement and minimal technological integration, often relying on glass cases and extensive textual descriptions to convey information (Stobiecka, 2020). This curatorial approach remains prevalent in many museums, where visual and textual stimuli dominate, fostering passive spectatorship (to a certain level) rather than active engagement.

Recent scholarship in sociocultural research, behavioral sciences, and museum marketing underscores a shift toward an embodied spectatorship, where multimodal engagement through sensory and bodily experiences becomes integral to meaning-making (Christidou & Pierroux, 2019; Pine & Gilmore, 1999). Visitors interact with exhibits not solely through visual and textual analysis but also through physical movement, gestures, auditory elements, and olfactory cues. These multisensory elements function as crucial sources of information, enriching interpretation beyond verbal and visual modes alone. Empirical research employing eye-tracking methodologies further

demonstrated that the integration of sensory elements—such as audio, music, and scent—can significantly enhance visitor attention, leading to improved visual recognition and knowledge retention (e.g., Garbutt et al., 2020; Kjellmer, 2021; Pelowski et al., 2018). Howes (2014) argued that the conventional perception of museums as exclusively visual domains constrains the potential for enriched visitor experiences and deeper engagement.

Immersive exhibitions: experiences, authenticity, and technology

Given the growing recognition of visitor experiences as fundamental to museum engagement, contemporary scholarship is critically reassessing object-oriented spectatorship and exploring hybrid models that integrate sensory-rich, technological interventions. This paradigm shift aligns with the broader emphasis on experiential engagement as a determinant of visitor satisfaction and behavioral intentions (e.g., Ali et al., 2016; Pine & Gilmore, 1999). Hooper-Greenhill (2000) similarly highlighted the evolving values in museum communication and learning, noting that traditional transmission-based education models—where knowledge is authoritatively imparted to passive audiences—are increasingly being replaced by constructivist, behaviorist, and interpretivist approaches. These frameworks prioritize experiential learning, cultural contextualization, and the understanding of education as an interactive process that extends beyond the mere transmission of factual knowledge. Levent et al. (2014) also emphasized that cognition is inherently embodied, meaning that visitors engage with museum environments through multiple sensory modalities, reinforcing the notion that museum experiences extend beyond passive visual encounters.

The concept of authenticity, central to curatorial practices, has also become a focal point of scholarly debate, particularly in the context of immersive exhibitions (Gilmore & Pine, 2007; Thouki, 2024). The literature identifies three primary conceptualizations of authenticity: objective, constructive, and existential (Thouki, 2024). Objective authenticity relates to the originality and historical accuracy of objects, while existential authenticity is associated with subjective, experience-driven engagement (Zhu et al., 2024). Constructive authenticity is a socially constructed and contextually determined notion: objects are constructed as authentic in terms of points of view, beliefs, and perspectives (Thouki, 2024). While objective authenticity remains a cornerstone of visitors' engagement, empirical research indicates that existential authenticity significantly enhances visitors' sense of presence and influences behavioral intentions, particularly within immersive and augmented reality settings (Zhu et al., 2024). This suggests that authenticity is not a fixed property but can be fluid, context-dependent, and subjective—a hybrid construct of interactions between environments and perceptions. Immersive environments grounded in existential authenticity may thus offer an alternative mode of museum engagement in both visual and auditory elements, complementing or even challenging the traditional object-centered format.

Furthermore, the integration of sensory-immersive technologies, including VR/AR, and video mapping techniques, has encouraged museums to adopt multisensory representation to enhance visitor engagement and immersion. *Immersive exhibitions* are thus characterized by embodied, experience-centered, and technology-integrated curatorial strategies. Unlike traditional exhibitions, which prioritize visual engagement, immersive exhibitions leverage sensory-immersive technology to enhance visual and

auditory engagement. Moreover, various objectives can be achieved through the immersive format: (1) to create esthetic artworks (e.g., olfactory art, Kjellmer, 2021), (2) to facilitate information transformation (e.g., virtual reconstruction, Simone et al., 2021), and importantly, (3) to trigger embodied perceptions through bodily experiences, which involve both physiological events and intellectual judgments (Joy et al., 2003).

In immersive exhibitions, audio guides are commonly used to convey information; however, they frequently adopt a first-person narrative style rather than the third-person perspective typical of traditional exhibitions. Lambert (2013) noted that the first-person voice enhances digital storytelling by fostering a more personal and immersive experience. This approach aligns with Whitelaw's (2008) argument that sound and image are inherently interconnected, with synesthetic principles often invoked in audio-visual art. Furthermore, research indicated that the integration of congruent scents with audio-visual stimuli can enhance visitor engagement and cognitive recall. For example, Sona et al. (2019) found that sensory-enriched environments, facilitated by congruent scent stimuli, contribute to increased perceptual fascination, a heightened sense of presence, and enhanced emotional resonance. These findings underscore the potential of sensory-immersive environments to deepen visitor engagement and support the transformation of museum experiences.

This evolving landscape of curatorship necessitates further exploration of the comparative impact of traditional and immersive exhibitions, particularly concerning the role of multisensory elements in shaping visitor experiences. By examining the integration of sensory-rich technologies in contemporary curatorial practices, this research aims to contribute to a more nuanced understanding of how sensory design can enhance engagement and satisfaction in museum settings and the added values of immersive exhibitions over the traditional format which focuses on visual engagement.

Visitor experience framework: the experience economy

In light of a notable shift from standardized offerings to providing unique and memorable experiences for visitors—experiences they are likely to remember and cherish even after their visit—the experience economy has gained considerable attention in recent years within visitor studies (Lee et al., 2020; Pine & Gilmore, 1999; Zhang et al., 2021). Pine and Gilmore (1999) first introduced the concept of *experience economy*, positing that experiences represent a new type of company offering and serve as a competitive advantage for organizational success. This evolution of economic value reflects a differentiation from competitors by staging unforgettable customer experiences. The concept emphasizes a service-oriented approach that prioritizes the creation of memorable experiences and highlights the importance of customer participation, absorption, and immersion across four experience realms: esthetic, entertainment, education, and escapism (Mehmetoglu & Engen, 2011). Similarly, in the field of museum studies, the potential for museum marketing has garnered significant attention, necessitating a reorientation of museums to understand visitors as cultural customers. For instance, Kotler et al. (2008) argued that defining missions, building audiences, and generating revenue and resources are essential for a museum's development. Cole (2008) viewed museum marketing as a tool for survival and creativity from the perspective of a mining museum. This notion of museum marketing reflects a fundamental shift

within museums, moving from traditional object-centered approaches to immersive visitor-centered experiences through experiential marketing (Kirezli, 2011; McLean, 2012).

As a result, Pine and Gilmore's four experience realms are frequently used as a theoretical base to study visitor experiences in museums and their evaluations of the museum environment (e.g., Lee et al., 2020; Mehmetoglu & Engen, 2011). In these survey-based studies, the four experience realms function as a holistic mechanism whereby diverse stimuli interact and influence the visitor experiences. Mehmetoglu and Engen (2011) indicated that Pine and Gilmore's model can further our understanding of the experience market. By comparing two different contexts between a festival and a museum, their study revealed that the dimension of escapism significantly affects visitor satisfaction in a festival context. In contrast, in a museum context, the education dimension plays a more critical role.

Hypotheses development

Visitor satisfaction

Satisfaction is the customer's evaluation of a product or service concerning whether that product or service has met the person's needs and expectations (Setó-Pamies, 2012). In the museum context, visitor satisfaction can be a reliable measurement of both objective effectiveness and subjective perceptions toward the specific exhibition design and the involved technical application in a museum (Kang et al., 2018). According to prior research, visitors' satisfaction is closely related to their visiting experiences toward a specific exhibition. This satisfied evaluation will later on influence their behavioral intentions, such as positive word-of-mouth appreciation, recommendations, and revisit intentions in the future (Ali et al., 2016; Jeong & Lee, 2006; Oliver, 1980; Pekarik et al., 1999). These behavioral intentions represent the features of visitor loyalty toward a specific museum, which makes great sense to the long-term relationship between visitors and the particular museum. Ali et al. (2016) showed that creative-tourist experiences with five dimensions, namely escape and recognition, peace of mind, unique involvement, interactivity, and learning, function as predictors of visitor satisfaction and behavioral intentions. In Kang, Jang and Jeong's (2018) concept of visitor satisfaction, experiences of technical usefulness, ease of use, enjoyment, and interactivity directly affect satisfaction toward the mobile guide system.

Visitor's sensory intensity and attention

To further elaborate our understanding of the multisensory process between visitors and exhibitions, two critical elements inevitably demand our attention: sensory intensity and attention. "Sensory intensity" refers to the perceived intensity or amplitude of sensory attributes in an environment, a continuum from low to high sensory perception (e.g., taste, touch, sight, sound and smell; Matthews et al., 2011; Nissen, 1977). The sensory intensity can be influenced not only by individual characteristics (e.g., age, gender, and preference; Balea & Nelson, 2020), but also by the nature of senses themselves (e.g., sensory category scales, amount of added senses; Noppeney et al., 2018). With the development of technology, technical representation is also widely applied

to provide "extreme" and "immersive" exhibitions to visitors (e.g., Crouch & Damjanov, 2021; Lee et al., 2020; Shin & Jeong, 2022). There are also pieces of evidence in prior research that an intense sensory environment can influence visitors' attention and their perception of time duration, which contribute to visitors' memorable and unique museum visiting experiences (Matthews et al., 2011). According to Bitgood's (2016) argument, visitor attention is related to a group of psychological processes involving a three-stage continuum of capture, focus, and engagement. "Visitors appear to compute (usually without conscious awareness) the perceived value (potential benefits divided by costs) of approaching, viewing, and engaging with an exhibit element" (Bitgood, 2016). Learning, satisfaction, or other deeply engaging experiences are outcomes of the attention that visitors give during the interactive sensory process.

Drawing from the previous literature review, a sensory-enriched environment is assumed to trigger greater attention, consequently influencing visitors' experiences and overall satisfaction. Moreover, pieces of evidence also demonstrate that sensory cues have a positive impact in triggering unique and memorable experiences. In this research, we use Pine and Gilmore's four experience realms to study and evaluate visitors' experiences and expect a positive impact of sensory cues on diverse experiences. Therefore, we postulate the following set of hypotheses:

H1. In the immersive exhibition, visitors will experience (a) higher sensory intensity, (b) higher attention level, (c) higher esthetic perception, (d) higher education, (e) higher entertainment, (f) higher escapism, and (g) higher satisfaction, than visitors in the traditional exhibition.

In this study, we hypothesize that environments with intense sensory stimuli elicit more positive reactions than those with less intense stimuli, regardless of exhibition type. Consistent with the Stimulus–Organism–Response (SOR) model by Mehrabian and Russell (1974), sensory cues in the environment (S) trigger internal cognitive, emotional, and physiological responses (O), which drive behavioral outcomes (R) such as approach or avoidance behaviors. The SOR model has been widely applied in environmental psychology and related fields. Willems et al. (2021) used it to examine store atmospherics, linking representation medium (S) to customer satisfaction (R) *via* experience dimensions (O). Similarly, Shin and Jeong (2022) applied the model in tourism, demonstrating that sensorial components of virtual trips enhanced immersion and nostalgia, increasing revisit intentions. Building on this framework, the current study uses sensory intensity as the stimulus (S), visitor attention and experience dimensions as organism variables (O), and visitor satisfaction as the response (R), leading to a second set of hypotheses:

H2. The relationship between "sensory intensity" and "satisfaction" is mediated by (a) visitor attention and four experience dimensions of (b) esthetic, (c) education, (d) entertainment, and (e) escapism.

Methodology

Design and exhibition selection

A field study was conducted in two Belgian museums, comparing visitors' responses in a traditional and an immersive exhibition (see Figure 1). The traditional

Figure 1. (Left): Low sensory inputs – the traditional exhibition of the Brueghel Hall in MSK gent. (Right): High sensory inputs – the immersive exhibition of "Meet the Masters" in the Brussels Dynasty Building.

exhibition—Brueghel Hall at the Museum voor Schone Kunsten Gent (MSK)—displayed authentic artworks by Brueghel alongside pieces by contemporary artists. This exhibition followed an object-centered curatorial approach, emphasizing objective authenticity by highlighting the originality and historical accuracy of the paintings. Visitors primarily engaged visually with the artworks, accompanied by textual labels providing factual information, such as title, artist, and creation date. Only 30.5% of participants reported using a narrative, third-person audio guide for additional information. As no significant differences were found in visitor reactions between those who used audio guides and those who did not in the traditional setting, data from both conditions were pooled for subsequent analyses.

In contrast, the immersive exhibition, *Meet the Masters*, at the Brussels Dynasty Building, featured digital renderings of works by Jan van Eyck, Pieter Brueghel, and Peter Paul Rubens. Grounded in existential authenticity, which emphasizes subjective, experience-driven engagement, the exhibition retained the core content of Flemish paintings while prioritizing an immersive, multisensory experience. In contrast to the previous traditional exhibition, it incorporated personalized, first-personal audio guides as part of a multisensory strategy, as well as enhanced visual engagement through dynamic, large-scale projections and 360° visual immersion. This form of auditory and visual engagement is fundamentally different from the traditional format—not an optional add-on but a core sensory feature of exhibition design, contributing to deepen the senses of presence and visitor engagement.

Participants

A total of 356 valid respondents participated in the study (see Table 1), with a composition of 60.3% female, an average age of 37.7 years (SD = 16.4; range: 18–83). Respondents rated their visit experiences in one of the two exhibitions: the immersive exhibition ($N = 181$) or the traditional exhibition ($N = 177$). All participants were able to perceive the sensory cues in the environment (e.g., vision, sound) without any sensory disabilities. Approximately half of the participants were Belgian (53.1%), followed by French (8.9%) and Dutch (6.4%). Over half of the respondents held a

bachelor's degree or higher (31.1% with a bachelor's degree and 37.4% with a master's degree). In terms of motivations for visiting an exhibition, based on multiple-choice responses (Pekarik et al., 2014), the most frequently selected reasons included "to enjoy an artistic atmosphere" (30%), "to enjoy the art exhibition" (30.6%), and "to spend time with family/friends/others" (23.1%), while only 12.7% indicated "to learn new ideas." Given the significant importance of prior knowledge in shaping visit experiences, this construct was assessed through three self-report items (Falk & Storksdieck, 2005): (1) familiarity with similar exhibitions featuring Flemish art, (2) knowledge of the relevant Flemish artists, and (3) understanding of the exhibition context before the visit.

In this case, we provided an overview of visitors' motivations for attending the exhibitions; however, we did not explicitly account for the influence of social dynamics, such as whether visitors attended alone or in groups. At the same time, we controlled for key socio-demographic variables (i.e., gender and age) as well as prior knowledge to better understand the impact of sensory intensity on visitors' experiences, as detailed in the following section.

To ensure that visitors to both exhibition types did not differ in terms of socio-demographics and prior knowledge, chi-square tests (for categorical variables) and t-tests (for continuous variables) were conducted to compare socio-demographic factors with exhibition type. The results confirmed that the distributions of gender ($\chi^2(2) = 2.44$, $p = .30$), degree ($\chi^2(5) = 6.55$, $p = .26$), and prior knowledge ($t(345.75) = .07$, $p = .95$) were comparable across both conditions. However, regarding age,

Table 1. Demographic characteristics of respondents for the two exhibitions ($n_{total} = 358$).

		$N_{immersive} = 181$		$N_{traditional} = 177$	
Characteristics		Frequency	Percent (%)	Frequency	Percent (%)
Gender	Female	115	36.5	101	57.1
	Male	66	63.5	75	42.4
	Other	0	0	1	0.6
Age	18–30	69	38.1	97	54.8
	31–50	59	32.6	40	22.6
	51–70	47	26.0	36	20.3
	71+	6	3.3	4	2.3
Nationality	Belgium	108	59.7	82	46.3
	France	18	9.9	14	7.9
	Netherlands	4	2.2	19	10.7
	China	10	5.5	10	5.6
	German	4	2.2	13	7.3
	UK	2	1.1	9	5.1
	Other	35	19.3	30	16.9
Degree	Primary school	1	0.6	1	0.6
	Secondary school	39	21.5	43	24.3
	Bachelor's degree	69	38.1	46	26.0
	Master's degree	60	33.1	74	41.8
	Doctoral degree	11	6.1	11	6.2
	Other	1	0.6	2	1.1
Motivation (multiple choice)	To learn new ideas	34	9.7	52	16.0
	To spend time with my family/friends/ others	90	25.6	66	20.4
	To enjoy an artistic atmosphere	104	29.5	99	30.6
	To enjoy the art exhibition	118	33.5	89	27.5
	Other	6	1.7	18	5.6

respondents in the immersive exhibition ($M = 40.21$; SD = 15.97) were significantly older than those in the traditional exhibition ($M = 35.12$; SD = 16.44; $t(356) = 2.97$, $p < .01$). Since age might influence the effect of exhibition type on sensory intensity (Nissen, 1977), we considered it a potential moderator in our analyses. Nonetheless, we found no significant main or interaction effects related to age on sensory intensity; therefore, we do not discuss those analyses further.

Procedure

Participants were randomly approached at each exhibition upon completing their visit, and structured questionnaires were administered following the acquisition of their consent. Anonymity was guaranteed, and no minors were involved in this study. Surveying visitors immediately after their visit facilitated the collection of their perceptions and evaluations of the recently completed experience while their impressions remained clear and fresh (Pallud, 2017). Data collection occurred during weekends and weekdays, allowing respondents freedom to explore the exhibition for as long as they wished.

Measurements

Participants were initially requested to provide information on socio-demographic variables, prior knowledge and visit motivations. Subsequently, they rated their perceptions of sensory intensity, attention, the four experience dimensions, and overall satisfaction (descriptive statistics and inter-construct correlations are presented in Table 2). All variables were assessed using seven-point Likert scales (totaling 20 items, where 1 = strongly disagree and 7 = strongly agree), with items adapted from previous research to suit the needs of this study.

Measurement items for sensory intensity were developed based on the definitions and characteristics of stimulus intensity outlined by Nissen (1977) and Matthews et al. (2011) (α = .74). Participants in both exhibition conditions responded to two statements, such as, "I strongly felt the lights, colors, darkness, and images." Attention was assessed using four items, reflecting its definition as a high-level visitor attraction characterized by a psychological continuum of capture, focus, and engagement (Bitgood, 2016; α = .85), An example item is, "I had a high-level sensory attraction and fewer distractions during my visit." For the visitor experience dimensions based on Pine and Gilmore (1999) experiential framework, measurement items were adapted from two studies (8 items, α = .82, Lee et al., 2020; Oh et al., 2007). An exploratory factor analysis using Principal Component Analysis revealed that the esthetic dimension was measured by three items (e.g., "The exhibition provided very detailed artistic elements"), education by two items (e.g., "It increased my knowledge about Flemish artists"), entertainment by two items (e.g., "I felt very relaxed during my visit"), and escapism by one item (i.e., "I forgot myself and seemed to become someone else during my visit"). Lastly, satisfaction was measured using three items (α = .92), adapted from Oliver (1981) and Setó-Pamies (2012). Participants rated their agreement with statements such as, "I'm very satisfied with this exhibition," on a seven-point Likert scale. An overview of the measurement items, along with the results of exploratory factor analyses and reliability analyses, can be found in Supplementary Appendix B.

Table 2. Descriptive statistics and inter-construct correlation ($N = 358$).

Structures	M	SD	1	2	3	4	5	6
1. Sensory intensity	5.37	1.22						
2. Attention	5.43	1.12	.73**					
3. Esthetic	5.61	1.13	.61**	.72**				
4. Education	4.84	1.37	.41**	.55**	.46**			
5. Entertainment	5.84	1.03	.49**	.65**	.66**	.41**		
6. Escapism	2.99	1.67	.17**	.19**	.20**	.39**	.12**	
7. Satisfaction	5.69	1.18	.58**	.71**	.78**	.47**	.68**	.23**

Notes: Pearson correlation-bivariate correlation. Superscripts.
**indicate that correlation is significant at the .01 level (2-tailed).

Table 3. Impact of exhibition type (traditional vs. immersive) on sensory intensity, attention, experience dimensions, and satisfaction.

				M(SD)	
Dependent measures	T	P[b]	Cohen's d	Immersive exhibition ($N = 181$)	Traditional exhibition ($N = 177$)
Sensory intensity[a]	7.38	<.001	1.14	5.81 (1.10)	4.92 (1.19)
Attention	6.86	<.001	1.05	5.81 (1.04)	5.05 (1.07)
Esthetic	2.82	.005	1.12	5.77 (1.19)	5.44 (1.04)
Education	3.50	<.001	1.35	5.08 (1.31)	4.58 (1.40)
Entertainment	2.84	.005	1.02	5.99 (1.04)	5.68 (.99)
Escapism[a]	−1.53	.128	1.66	2.86 (1.72)	3.13 (1.60)
Satisfaction	2.69	.007	1.17	5.86 (1.26)	5.52 (1.08)

Note: M, mean; SD, standard deviation. Superscript.
[a]indicates unequal variances assumed. Superscript.
[b]indicates the results of a two-sided P value.

Results

Effect of exhibition type on diverse visitor reactions

To test hypotheses 1a through 1 g, independent t-tests were conducted. The results indicated that exhibition type has a statistically significant effect on sensory intensity, attention, esthetic experience, education, entertainment, and overall satisfaction (all two-tailed $p < .008$, with Cohen's d values ranging from 1.02 to 1.35, indicating large effects according to Cohen, 1988). However, no significant effect was found for escapism (two-tailed $p = .128$, Cohen's $d = 1.66$). Summary statistics can be found in Table 3. Overall, visitors to the immersive exhibition reported more intense sensory experiences, greater attention, higher ratings for three out of four experience dimensions (esthetic, education, entertainment), and increased satisfaction compared to visitors of the traditional exhibition. Consequently, hypothesis 1f is rejected, while hypotheses 1a, 1b, 1c, 1d, 1e, and 1 g are supported.

Effect of sensory intensity on visitor satisfaction via attention and visitor experience

To test the second set of hypotheses, a serial and parallel mediation analysis was conducted using the customized PROCESS macro for SPSS (Hayes, 2017; see Figure 2). Direct and indirect effects were estimated using Ordinary Least Squares regression (OLS) and bootstrapping analysis with 10,000 samples and a 95% confidence interval (CI).

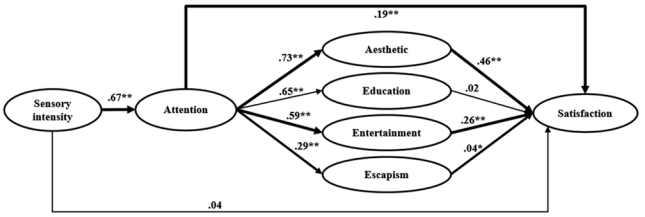

Figure 2. A statistical diagram of the serial and parallel mediation model. Numbers represent unstandardized beta coefficients. Superscript **indicates $p \leq .001$; superscript *indicate $p < .100$. Arrows in bold indicate mediation (95% confidence interval).

Table 4. Total and direct effect of sensory intensity on visitor satisfaction.

	Total effect		Direct effect	
	Coeff. (SE)	P	Coeff. (SE)	P
Constant	5.86 (.09)	<.001	−0.08 (.24)	.751
Sensory intensity	.56 (.04)	<.001	.04 (.04)	.309
Attention			.19 (.06)	.001
Esthetic			.46 (.05)	<.001
Education			.02 (.03)	.485
Entertainment			.26 (.05)	<.001
Escapism			.04 (.02)	.074
	R^2 = .34		R^2 = .68	
	F (1, 356) = 182.77		F (6, 351) = 123.94	
	p < .001		p < .001	

Note: In line with Hayes (2017), we label the total effect as the effect of sensory intensity on visitor satisfaction. The direct effect is the effect of sensory intensity on visitor satisfaction, controlling for attention, esthetic, education, entertainment, and escapism. Coeff. = unstandardized regression coefficients; SE = standard errors.

Table 5. Indirect effects (through attention and experience dimensions) of sensory intensity on visitor satisfaction.

Indirect effects on visitor satisfaction through	Coeff. (SE)	CL_{Low}	CI_{Up}
Attention*	.13 (.05)	.04	.22
Attention → esthetic*	.23 (.04)	.15	.30
Attention → education	.01 (.02)	−0.02	.04
Attention → entertainment*	.10 (.02)	.06	.15
Attention → escapism*	.01 (.01)	.01	.02

Note: The indirect effect is the effect of sensory intensity on visitor satisfaction through attention, esthetic, education, entertainment, and escapism. A serial and parallel mediation model was estimated. A bootstrapping analysis with 10.000 samples and a 95% confidence interval was conducted. If the confidence interval does not include zero, then mediation occurs. Coeff. = unstandardized regression coefficients; SE = standard errors; CL_{Low} = Lower limit confidence interval; CI_{Up} = Upper limit confidence interval.
*indicates mediation.

Sensory intensity served as the independent variable, while attention, esthetic experience, education, entertainment, and escapism acted as serial mediators, with satisfaction as the dependent variable. An overview of the direct and indirect effects on visitor satisfaction is presented in Tables 4 and 5.

Regarding the direct effect, the analysis revealed that the difference in experienced sensory intensity did not significantly affect visitor satisfaction when controlling for attention and the four experience dimensions (β = .04, SE = .04, p = .309). Additionally, no direct effect was found for education on visitor satisfaction after controlling for

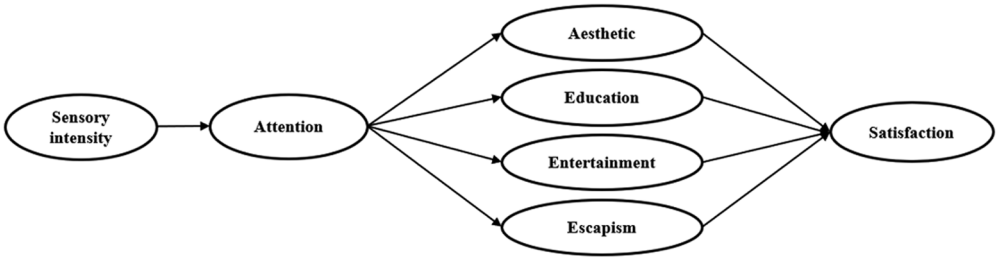

Figure 3. Proposed serial mediation model toward the impact of sensory intensity on satisfaction.

sensory intensity (β = .02, SE = .03, p = .485). In contrast, attention (β = .19, SE = .06), esthetic experience (β = .46, SE = .05), and entertainment (β = .26, SE = .05) exhibited significant positive direct effects on visitor satisfaction (all $p \leq .001$), while escapism (β = .04, SE = .02) showed a marginally significant positive effect (p = .074).

To test the proposed serial and parallel mediation model regarding the impact of sensory intensity on visitor satisfaction, the indirect effects of sensory intensity on visitor satisfaction *via* attention and the four experience dimensions were examined (see Table 4). Sensory intensity was found to indirectly influence visitor satisfaction through (1) attention (CI [.04, .22]), (2) attention followed by esthetic experience (CI [.15, .30]), (3) attention followed by entertainment (CI [.06, .15]), and (4) attention followed by escapism (CI [.01, .02]). Given the non-significant direct effect of sensory intensity, these findings suggest the presence of indirect-only mediations (Zhao et al., 2010).

Specifically, a higher perceived intensity of sensory attributes in an environment increases visitor attention (β = .67, $p < .001$), which in turn enhances esthetic experience (β = .73, $p < .001$), entertainment (β = .59, $p < .001$), and escapism (β = .29, $p < .001$), ultimately leading to increased satisfaction ($\beta_{aesthetic}$ = .46, $p < .001$; $\beta_{entertainment}$ = .26, $p < .001$; $\beta_{escapism}$ = .04, p = .074). However, the experience of education does not lead to greater satisfaction ($\beta_{education}$ = .02, p = .485), although increased visitor attention positively influences the educational value ($\beta_{education}$ = .65, $p < .001$). Consequently, hypotheses 2a, 2b, 2c, 2e, and 2f are confirmed, while hypothesis 2d is rejected. A statistical diagram illustrating the serial and parallel mediation is provided in Figure 3.

Discussion

Based on the *experience economy* framework and the S-O-R model, this research explored the added values of immersive exhibitions over the traditional format by examining visitor responses to two different exhibitions and investigating the impact of sensory intensity on satisfaction. The two exhibitions analyzed in this study differ in their sensory intensity: (1) the traditional exhibition: grounded in an object-centered curatorial approach emphasizing objective authenticity, this format features real artworks for visual engagement, and (2) the immersive exhibition: grounded in an experience-centered curatorial approach emphasizing existential authenticity, this format presented digital artworks with enhanced visual and auditory engagement. Sensory-immersive technologies—including first-person audio guides, video mapping, and 360° projection techniques—were integrated in the immersive exhibition to create a more immersive and interactive experience.

Theoretical implications

The findings indicate that the immersive exhibition (vs. the traditional exhibition) elicits more positive visitor responses by enhancing sensory intensity, attention, esthetics, education, entertainment, and overall satisfaction. The results support the notion that exhibitions incorporating sensory-immersive technology effectively heighten sensory engagement. Furthermore, the integration of these technologies demonstrates clear advantages in capturing visitor attention while minimizing distractions. Grounded in the *experience economy* framework, visitor experiences are multidimensional, encompassing four realms: esthetics, education, entertainment, and escapism. Among these, the immersive exhibition in the present study significantly enhances esthetic, educational, and entertainment experiences. Notably, contrary to concerns that immersive exhibitions may prioritize entertainment at the expense of public education, this study finds that they positively contribute to both esthetic appreciation and learning outcomes.

Interestingly, no significant difference was observed between the two exhibition types for the parameter escapism (e.g., "I forgot myself and seemed to become someone else during the visit"). This may be attributed to a weaker sense of presence or the similarity of content in both settings. Research suggests that virtual or augmented reality applications are more effective in enhancing presence and mental imagery during art appreciation (Carrozzino & Bergamasco, 2010; Yi & Kim, 2021). However, this study did not involve VR/AR technologies. Additionally, as both exhibitions presented similar educational content about Flemish artists, visitors may have experienced comparable levels of escapism.

Most hypotheses were supported, highlighting the relationship between sensory intensity and visitor satisfaction, mediated by attention and subsequent experiences of esthetics, entertainment, and escapism. These findings underscore that visitor attention and associated experiential dimensions are key mechanisms linking sensory intensity to satisfaction. Aligning with Bitgood's (2016) argument, deeply engaging experiences and satisfaction stem from heightened attention regardless of exhibition type. Environments with intense sensory stimuli encourage focused attention, which, in turn, enhances esthetic, entertainment, and escapism experiences, leading to higher satisfaction.

Although the immersive exhibition produced higher educational outcomes than the traditional one, the study found that entertainment, esthetics, and escapism contributed more significantly to visitor satisfaction in relation to sensory intensity. Notably, perceived sensory intensity indirectly influenced visitor satisfaction through attention and escapism. However, the lack of difference in escapism between the exhibition types suggests that intense sensory environments amplify attention, which triggers a higher level of escapism and ultimately enhances satisfaction with the overall experience.

Managerial implications

Our findings offer significant practical implications, highlighting the critical role of sensory cues as environmental enhancers in exhibition design. To foster deeper public engagement, future exhibitions should emphasize the integration of intensified sensory experiences, particularly through the use of immersive sensory strategies. As

demonstrated in this study, auditory engagement can be enhanced through personalized first-person audio guides (rather than narrative third-person ones), and visual immersion can be achieved *via* video mapping and 360-degree projection techniques. Effective soundscape design has been shown to strengthen visitors' perceptions of realism and evoke a stronger sense of "being there" (Rudi, 2021). The selection and appropriateness of signal types in sound production play a critical role in shaping these immersive experiences.

Furthermore, audio-visual technologies remain widely adopted in museum contexts due to their cost-effectiveness and ease of implementation. From both practical and budgetary perspectives, museums may also incorporate accessible tools—such as touchscreens, temperature sensors, haptic devices, and hands-on activities—to further enhance visitor engagement and amplify the influence of sensory cues. These approaches not only elevate the sensory richness of exhibitions but also align with the growing demand for interactive and engaging cultural experiences. For instance, contemporary digital trends in the museum sector include interactive installations designed for social media sharing, such as photo-taking zones and Instagram-friendly exhibits (Zingone, 2024), as well as large-scale immersive environments developed by collectives like TeamLab, which use digital technologies to create dynamic and responsive artworks (https://www.teamlab.art/). Computer vision analyses of visitor-generated Instagram content reveal a preference for interactive engagement over passive documentation (e.g., selfies), highlighting the importance of participation in shaping meaningful museum experiences (Rhee et al., 2022). Our findings provide further empirical support for these developments, demonstrating that intensified sensory design can capture visitors' attention, subsequently enhancing the esthetic appeal and entertainment value of exhibitions, thereby increasing visitor satisfaction. Museums are therefore encouraged to integrate sensory strategies more confidently into their broader digital and experiential frameworks.

Beyond these technological approaches, additional strategies for enhancing sensory intensity are recommended. One effective method is the incorporation of olfactory cues, either through ambient scent diffusion or the integration of scented objects within the exhibition space. Encouraging tactile interaction is another accessible strategy; for example, replicas of original artworks can be made available for visitors to explore texture and form through touch. Additionally, leveraging cross-modal sensory associations, inspired by the concept of synesthesia, offers an innovative approach to exhibition design (Whitelaw, 2008). Commonly employed by experimental contemporary artists, this method can also be applied to historical artworks or artifacts. For example, a painting depicting a sunlit floral scene could be complemented by soft background music or a warm ambient temperature, reinforcing sensory connections and deepening visitor engagement.

More importantly, our research sheds light on the underlying mechanism through which perceived sensory intensity influences visitor satisfaction. Exhibitions with intense sensory attributes capture greater attention, leading to enriched esthetic, entertainment, and escapism experiences, which ultimately enhance overall satisfaction. To achieve more positive evaluations, museums should prioritize sensory intensity and consider its interplay with visitors' attention control systems. At the pre-visit stage, museums can incorporate multisensory elements into exhibition designs to maximize perceived

sensory intensity. Cross-disciplinary collaboration among curators, technicians, chemists, and art historians is essential for creating high-quality sensory experiences. Effective promotional strategies, such as visually appealing advertisements and announcements on websites or social media, can also attract visitors' interest and set expectations. During the visit, minimizing distractions is crucial for maintaining visitors' focus and engagement. Elements like excessive noise or poorly designed guiding routes that confuse or frustrate visitors should be avoided. Instead, clear pathways and immersive environments that promote uninterrupted attention should be prioritized. Museums can also enhance visitors' experiences by fostering esthetic, entertainment, and escapism dimensions, which strongly contribute to intrinsic hedonic values (Lee & Jeong, 2020). By addressing both sensory and attentional factors, museums can create exhibitions that are both impactful and memorable.

Limitations and suggestions for further research

This study has several limitations that offer directions for future research. First, it focused exclusively on (1) two representative exhibition formats—traditional and immersive (see figures and curatorial descriptions), and (2) how sensory intensity influences visitor satisfaction. While this approach provides valuable insight into immersive sensory strategies, it did not consider the role of social dynamics or group-based meaning-making processes. It would be interesting to examine how immersive technologies may constrain or support shared experiences, collaborative interpretation, and interpersonal dialogue—especially in contrast to the inherently social nature of traditional group visits and facilitator-led engagement. Future research is also encouraged to expand the range of exhibition cases, incorporating a broader diversity of both traditional and immersive formats to enhance the generalizability of the findings. Second, although the study examined sensory experiences as an integrated whole within each exhibition, it did not disentangle the effects of specific sensory modalities or combinations thereof. Future research could systematically investigate the differential impact of individual sensory cues (e.g., auditory vs. olfactory) and compare configurations with varying sensory load (e.g., one cue vs. two cues) to better understand optimal sensory integration strategies. Third, the study adopted Pine and Gilmore's four realms of experience to assess visitors' responses. While this framework offers a robust foundation for evaluating experiential dimensions, alternative models—such as flow theory, authenticity, psychological well-being, or individual experience preferences—may provide complementary or deeper insights into immersive and sensory experiences. In particular, the educational dimension in this study was measured using self-reported items, without assessing actual knowledge acquisition. Future research could incorporate objective learning metrics, such as recall tasks or comprehension tests, to strengthen inferences regarding educational outcomes. Fourth, this study was conducted in a real-world setting involving actual visitors. This approach enhanced external and ecological validity, albeit at the expense of some experimental control. Our findings revealed a significant difference in the perceived sensory intensity between the two exhibitions. However, it is crucial to acknowledge that additional noteworthy factors might contribute to the observed differences apart from the level of sensory inputs, such as the content presented by

different picture sets. For this reason, we tested the effect of sensory intensity on visitors' satisfaction *via* attention and experience dimensions, irrespective of the exhibition type. There remains a potential avenue for future research to explore the influence of exhibition type on visitors' reactions in a more controlled laboratory setting. Fifth, while this study relied on quantitative survey data, incorporating mixed methods—such as observational data, interviews, or open-ended responses—could enrich and validate the findings, offering deeper insights into visitors' subjective experiences. Finally, this study did not address hybrid exhibition formats that blend object-centered and immersive, embodied approaches. Exploring the design and experiential potential of such formats represents a promising avenue for future research on optimizing visitor engagement.

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Ethics statement

This study adhered to the ethical guidelines outlined by the Human Sciences Ethics Committee at Vrije Universiteit Brussel. Prior to conducting the research, the authors consulted the committee's instructions and guidelines to ensure compliance with research ethics. The study was classified as a non-interventional study (using surveys), and ethical approval was deemed not required. Participation in the study was entirely voluntary, and all participants were above 18 years of age, with no inclusion of vulnerable populations or minors. Written informed consent was obtained from all participants before the commencement of the study. Participants were provided with a clear explanation of the research purpose, the data collection process, and the intended use of the findings. They were informed about their rights, including the ability to withdraw at any time without any consequences. The anonymity of participants was strictly maintained throughout the research process. All data were anonymized during preparation, analysis, and reporting to ensure confidentiality and privacy. No identifying information was collected or stored that could link individual participants to their responses. By following these measures, this study ensured compliance with ethical standards for research involving human participants.

Authors' contributions

All authors contributed to the study conception and design. Material preparation and data collection were performed by DL. Both DL and LD contributed to the data analysis. The first draft of the manuscript was written by DL, and all authors commented on previous versions of the manuscript. All authors read and approved of the final manuscript.

Disclosure statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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