How immersive technologies impact behavioral responses in destination marketing: the role of physiological arousal, presence, and age

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Abstract

Purpose – This paper aims to investigate the effectiveness of immersive virtual reality (VR) media and the influence of user's age in the context of destination marketing by exploring their impact on cognition (presence), affection (arousal), and behavioral (intention to visit and intention to recommend the destination) outcomes.

Design/methodology/approach – A laboratory experiment was conducted to compare the impact of using immersive VR (vs. 2D desktop) to experience a 360-degree virtual tour of Valencia on consumers' behavior. The sample included 187 participants. Both self-reported and physiological measures were collected during the experimentation.

Findings – Results showed that participants in the immersive condition experienced a stronger sense of presence and higher physiological arousal than those exposed to nonimmersive content. Presence significantly mediated both the intention to visit and the intention to recommend the promoted venue. Physiological arousal mediated the relationship between media typology and the intention to recommend the destination. Upon introducing age as a moderating variable, the effect of physiological arousal on behavioral outcomes proves to be significant.

Practical implications – The study presents destination marketing organizations with a compelling use case for immersive technologies. It also offers design principles, potential applications and targeting strategies for VR marketing in hospitality management.

Originality/value – To the best of the authors' knowledge, this study is the first to investigate the combined effect of physiological arousal and presence on behavioral intentions in VR destination marketing, while also examining the impact of age as an individual characteristic.

Keywords Consumer behavior, Tourism, Virtual reality, Virtual experience, Emotions

Paper type Research paper

1. Introduction

360-degree virtual tours are digital simulations of a physical location, allowing viewers to interact with the virtual environment by exploring its surroundings. Recently, those video formats have witnessed a remarkable surge in demand, especially in destination marketing due to their potential to offer realistic "try before you go" experiences (Huang *et al.*, 2016; Tussyadiah *et al.*, 2018; Wu and Lai, 2023). 360-degree virtual tours are accessible through different media characterized by varying modes of interactions with the virtual environment (Flavián *et al.*, 2019). In particular, a substantial stream of research has recently started to investigate how immersive technologies enhance communication effectiveness and promotion of destinations before the journey. Previous literature in tourism management has explored the potential of immersive technologies to enhance potential travelers' attitudes and overall perceptions of a destination (Alyahya and McLean, 2022; Tussyadiah *et al.*, 2017). Immersive technologies have also been shown to increase the likelihood of repeating the experience (Guo *et al.*, 2024), the willingness to pay for it (McLean *et al.*, 2023), the intention to visit the promoted destination (Bogicevic *et al.*, 2021; Weng *et al.*, 2021) and to book accommodations or vacations (Martínez-Molés *et al.*, 2021; Orús *et al.*, 2021). Additionally, they have been found to encourage sharing the destination (Cheng and Huang, 2022; Flavián *et al.*, 2021) or the virtual reality (VR) experience (Griffin *et al.*, 2023; Yung *et al.*, 2021a) with others.

In destination marketing, the importance of emotional experiences has been increasingly recognized. Extant research emphasizes that such experiences significantly shape visitors' satisfaction and subsequent behavioral intentions (Prayag *et al.*, 2013; Quynh *et al.*, 2021). Furthermore, while traditional media such as smartphone and laptop displays usually provide low immersion and limited media interactivity, immersive technologies facilitate more intense experiences and an increased sense of presence (Gutierrez *et al.*, 2008). The sense of feeling present in a virtual destination is intricately linked to users' behavioral responses, and it is widely recognized as an essential feature of immersive technology in tourism (Choi *et al.*, 2016; Fan *et al.*, 2022; Yung *et al.*, 2021b). However, research into how emotions and presence influence behavioral intentions in this field remains nascent (Lemmens *et al.*, 2022; Yung *et al.*, 2021b) and often presents conflicting results. While some research suggests that VR-induced presence alone is insufficient to generate behavioral intentions (Choi *et al.*, 2016; Kim *et al.*, 2022), other studies propose that positive affective responses, including enjoyment (Hoang *et al.*, 2023; Kim *et al.*, 2022), pleasure (Cheng and Huang, 2022), and satisfaction (An *et al.*, 2021; Wei *et al.*, 2019) mediate this relationship. Conversely, some papers report no significant correlations between presence and satisfaction (Guo *et al.*, 2024) and propose the existence of a direct relationship between presence and behavioral intentions (Lee *et al.*, 2020; Martínez-Molés *et al.*, 2021; Orús *et al.*, 2021).

Notably, these studies predominantly rely on subjective self-reports of affective responses, which might lead to inaccurate results due to the limited precision of participants'

recollections. Emotional processing is primarily subconscious; therefore, customer value may be created during VR engagement, even if participants do not consciously remember it when providing post-exposure feedback (Beck and Egger, 2018). Consequently, self-reported and physiological measures are not always coherent (Beck and Egger, 2018; Bolinski *et al.*, 2021; Li *et al.*, 2018). Despite calls for a multi-modal approach and the acknowledged significance of the emotional constructs (Martínez-Molés *et al.*, 2021; Tussyadiah *et al.*, 2018; Yung *et al.*, 2021a), the application of physiological data for quantifying emotional responses in the literature remains scarce, especially in VR tourism research.

Last but not least, there is a paucity of research examining the influence of individual and demographic differences on tourism experience facilitated by VR technology. Despite the importance of exploring personal factors to adapt and personalize VR experiences to different audiences (Loureiro *et al.*, 2020), few efforts have been made in this direction. Indeed, previous literature focused on the differences in gender (Martínez-Molés *et al.*, 2021) and innovative traits (Bogicevic *et al.*, 2021), but no previous studies have explored the influence of age in shaping individual responses to immersive technologies in the tourism context.

The current research aims to address these gaps by examining the impacts of different media technologies (i.e. immersive VR vs 2D desktop) and users' age while interacting with 360-degree tours on physiological arousal and presence, and their influence on intentions to visit and recommend the promoted destinations. Overall, the paper presents three major contributions. First, adopting the overarching Stimulus-Organism-Response (SOR) framework as the foundation of this paper (Mehrabian and Russell, 1974), we aim to advance the understanding of how immersive experiences affect different travelers' behaviors by examining the interplay of cognitive and affective mediators. Second, our study contributes to the methodological discourse by adopting a physiological measurement of arousal, offering a more complete view of immersive experiences in the field of tourism. Finally, we investigate the role of users' age and its influence on behavioral intention. Through the theoretical lens of socioemotional selectivity theory (Carstensen *et al.*, 1999), we also explore the moderating effects of age on the effectiveness of immersive technologies. To the best of our knowledge, this is the first study considering the role of age in determining differential outcomes related to the use of immersive VR technology in destination marketing.

2. Theoretical framework

In destination marketing research, the impact of virtual technologies is often analyzed by employing the SOR model (An *et al.*, 2021; Kim *et al.*, 2020). This theoretical framework maps the relationship between external inputs (Stimulus), the internal processing by the individual interacting with the technology (Organism) and the subsequent individual actions (Response). The SOR framework is suitable for explaining consumer behavior in VR tourism by incorporating additional variables such as affective and cognitive responses and is particularly valuable for distinguishing the effects related to each variable (Kim *et al.*, 2020). In the present research, we explore varying modalities of VR content visualization as distinct forms of Stimuli, aligning with extant literature identifying stimuli as levers that destination marketing managers can use to tailor virtual experiences (An *et al.*, 2021). Second, we frame the Organism within the SOR framework to include both affective and cognitive responses. Affective responses are examined through the lens of arousal, namely the degree of emotional activation experienced during interaction with the VR content (Yeh *et al.*, 2017). On the other hand, we examine cognitive responses, including the sense of

presence, which relates to "a product of the mind which is not bound to any specific technology and describes the feeling of being there" (Beck *et al.*, 2019, p. 589). Finally, our model's Responses include intentions to visit and to recommend the destinations in question. While visit intention directly measures a possible benefit for destination marketing organizations, recommendations are crucial to customer engagement and represent one of the most influential sources of travel information and decision-making in tourism (Flavián *et al.*, 2021).

2.1 Effects of media type on affective and cognitive responses

Emotions have been identified as a critical factor in analyzing VR experiences among potential visitors, underscoring their importance in shaping individual intentions and behavior. The predominant approach in VR tourism literature adopts a basic emotions approach, focusing on discrete constructs such as pleasure, enjoyment and satisfaction (An *et al.*, 2021; Guo *et al.*, 2024; Martínez-Molés *et al.*, 2021; Nam *et al.*, 2023; Tussyadiah *et al.*, 2018; Wei *et al.*, 2019). However, these approaches present the risk of confining complex affective states to a few specific emotions, thus posing significant issues with their applicability and reliability. Unlike discrete emotion theories (Ekman *et al.*, 1983), the dimensional approach views emotions as combinations of different states measured on a continuous level. Arousal usually refers to internal state activations and serves as the foundation for numerous models in consumer research (Russell, 1980). Arousal theories maintain that emotions toward a specific stimulus arise when the object triggers certain physiological changes, which are then perceived internally and experienced as a general state of arousal or activation (Reisenzein, 2017). According to this perspective, arousal is the neurophysiological basis underlying emotion-generation processes, and it is "[…] the basis of emotions, motivation, information processing, and behavioral reactions" (Groeppel-Klein, 2005, p. 428).

Previous evidence in the tourism literature shows that different modalities of VR content visualization can affect self-reported arousal. For instance, Kim and colleagues demonstrated that head-mounted displays and CAVE systems can induce higher self-reported arousal than 2D desktop platforms (Kim *et al.*, 2014). More recently, in comparing pictures, videos, and VR stimuli of a cruise experience, Yung and colleagues found that immersive media significantly increases levels of self-reported arousal (Yung *et al.*, 2021a). In a similar vein, Flavián *et al.* (2021) found that immersive technologies induce higher levels of emotional reactions, with arousal being one of the primary components.

Among implicit markers, physiological arousal represents an activation of emotional experience and can be related to the sympathetic system's activity. Employing physiological measures to assess affective responses has been shown to address the limitations associated with self-reports, such as cognitive biases and social desirability (Paulhus, 2002). In previous studies, electrodermal activity (EDA) signals have been shown to be correlated with the media employed to deliver virtual experiences (Kuhne *et al.*, 2023). In the VR tourism context, Beck and Egger (2018) found that immersive technologies increase arousal measured through physiological activation, while no relationship between the media employed and self-reported emotional response was found. Drawing on this evidence, we hypothesize that destination marketing stimuli with greater immersive qualities will positively influence affective responses, as measured by physiological arousal. Formally, we propose:

H1. 360-degree immersive VR (vs. 2D desktop) tours elicit higher physiological arousal.

Immersion is commonly defined as the quantifiable features influencing the stimulation of the senses while simultaneously reducing the influence of stimuli from the real world (Lombard and Ditton, 1997). Specifically, elements such as display resolution, image quality, field of view, motion-tracking and haptic feedback collectively enhance a technology's immersive potential. Immersion plays a pivotal role in VR systems, being central to delivering the illusion for the user to become an integral part of the simulated world (Gutierrez *et al.*, 2008). The concept of presence, often referred to as telepresence (Steuer *et al.*, 1995), refers to the feeling of being physically present in a virtual environment despite being physically located elsewhere (Heeter, 1992).

In tourism, many studies focused on the concept of presence and its antecedents. Tussyadiah *et al.* (2018) found that presence is higher when technology with higher levels of interactivity is used during the experience. Similarly, An *et al.* (2021) showed that higher sensorial stimulation perceived by users can increase the feeling of being in the environment. Perceived media effectiveness was also demonstrated to be a significant antecedent of presence (Wei *et al.*, 2019). Besides the attributes of the medium employed for virtual content consumption, two primary categories widely acknowledged as antecedents to presence are media content and individual characteristics (Ijsselsteijn and Riva, 2003). While greater levels of immersion do not equate to a more pronounced sense of presence, content delivered using immersive media generally receives higher presence ratings than those delivered in 2D (Kuhne *et al.*, 2023; Lemmens *et al.*, 2022).

Different media, such as VR vs 2D desktop devices, present differences in vividness and interactivity (Yeh *et al.*, 2017). Also, VR headsets offer superior visual, audio and motion-tracking experiences, as well as a broader field of view compared to desktop PCs, thereby completely surrounding the user's senses in a virtual environment (Slater and Wilbur, 1997). In line with previous empirical investigations in destination tourism literature (Hoang *et al.*, 2023; Kim *et al.*, 2022; Tussyadiah *et al.*, 2017), we expect VR headsets to offer customers a greater sense of proximity with the virtual content with respect to 2D media, thus leading to more immersive experiences compared to external technologies (Biocca, 1997; Flavián *et al.*, 2019). Therefore, we propose the following hypothesis:

H2. 360-degree immersive VR (vs. 2D desktop) tours elicit a higher sense of presence.

2.2 The effects of affective and cognitive responses on behavioral intentions

The intensity of emotions plays a crucial role in shaping consumers' responses to destination marketing stimuli (Li *et al.*, 2018). Arousal has been shown to significantly affect individual approach or avoidance tendencies and individual choice intentions in different contexts (Walsh *et al.*, 2011). The intensity of arousal triggered by a certain product, service, or experience can serve as an indicator of the level of excitement over it and the following behavioral intentions (Beck and Egger, 2018). Specifically, arousal can affect the organization of positive and negative cognitions and attitudes, increasing the association between positive cognitions and attitudes while decreasing it for negative cognitions (Bagozzi, 1994). This notion is consistent with previous research in marketing, which has suggested that arousal experienced in the pre-purchase stage influences consumer judgments (Yan *et al.*, 2016), attitude toward a product (Bettiga *et al.*, 2017), and consumer buying decisions (Rajagopal, 2010). Also, experiences marked by surprise or novelty tend to enhance the likelihood of individuals sharing positive WOM feedback with others (Berger, 2011; Derbaix and Vanhamme, 2003).

In the tourism literature, Yung *et al.* (2021a) explored how immersive experiences affect interest in a cruise vacation compared to traditional photographic material. The authors

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identified a moderate correlation between self-reported arousal generated by immersive technologies and the intention to visit and recommend the cruise to others. Similarly, arousal has been shown to mediate the relationship between natural scenic environments and tourist experiences, where the level of arousal depends on visitors' reasons for being in those specific environments, reflecting goal-oriented behavior (Zhang and Xu, 2019). Building on arousal theory, Wang *et al.* (2020) also demonstrated that arousal levels act as an intermediary between tourist stimuli and individual experience. Based on this, we posit that heightened arousal could enhance the behavioral response regarding the intention to visit and recommend the promoted destination. Building on this and incorporating a physiological measure of arousal, we propose the following hypotheses:

H3a. Physiological arousal increases the intention to visit the promoted destination.

H3b. Physiological arousal increases the intention to recommend the promoted destination to others.

Reactions to increased arousal are not uniform across individuals. In particular, evidence suggests that older adults respond differently to emotional appeals than younger adults (van der Goot *et al.*, 2015). According to the socioemotional selectivity theory (Carstensen *et al.*, 1999), older individuals are more likely to process information in a subjective, emotional manner. In contrast, younger ones tend to focus on objective, factual details (Isaacowitz *et al.*, 2000). When making decisions, the tendency to assess time as limited or expansive influences individual goals' saliency. Socioemotional theory suggests that people who perceive their time as limited tend to give more importance to emotional content to regulate their affective states, and this notion is valid for consumer information processing as well (Isaacowitz *et al.*, 2000). In this perspective, age is a proxy for time horizon perspective, given that time perspective naturally becomes more limited as people age (Drolet *et al.*, 2011). Older adults have been shown to value personal experiences and values more highly (Carstensen and Reynolds, 2023), which impacts how affective content positively influences their responses. This distinction is supported by empirical research indicating that older individuals' motivations in processing marketing communications differ, emphasizing emotional over factual content. Previous studies showed that older adults usually prefer emotional rather than knowledge-related commercials, which affected their effectiveness (van der Goot *et al.*, 2015, 2021; Williams and Drolet, 2005).

Based on the previous discussion, we expect immersive technology to engender higher affective reactions when viewing 360-degree videos. In light of the socioemotional selectivity theory, we also expect a VR user's age to significantly moderate potential behavioral intentions, whereas older individuals show a stronger influence of physiological arousal on behavioral intentions. Accordingly, we propose the following hypotheses:

H4a. User's age moderates the relationship between physiological arousal and the intention to visit the promoted destination, such that younger users are less sensitive to the influence of physiological arousal on their intention to visit.

H4b. User's age moderates the relationship between physiological arousal and the intention to recommend to others the promoted destination, such that younger users are less sensitive to the influence of physiological arousal on their intention to recommend.

Presence has also been studied for its direct influence on consumers' behavioral intentions in VR marketing (Orús *et al.*, 2021; Pleyers and Poncin, 2020). Although an established relationship between presence induced by immersive media and behavioral intentions exists, research in tourism presents mixed results. In the context of VR advertising for cruise

vacations, Yung *et al.* (2021b) did not find any significant relationship between spatial presence and both intentions to visit and to recommend the destination. In their study on virtual tours, Kim *et al.* (2022) tested different models, concluding that presence did not impact behavioral intentions. These results are supported by Choi *et al.* (2016), who showed that presence has no impact on different navigational outcomes, including intention to visit, familiarity, product knowledge and interest. By employing a virtual experience for natural landscape tourism, Kim *et al.* (2022) proposed that the relationship between presence and behavioral intention is contingent upon the mediating effects of enjoyment encountered during the experience, suggesting a more complex interplay of factors. A different effect has been observed in a study involving promotional material for cruise vacations, showing a direct effect of presence on purchase intent (Martínez-Molés *et al.*, 2021). Presence has also been shown to induce changes in individuals' attitudes after exposure to VR (Tussyadiah *et al.*, 2017). While investigating the effects of immersive media in the pre-experience phase with the hotel room, Orús *et al.* (2021) found that adopting VR technology can increase potential guests' intention to book.

Given these contrasting results, more research investigating the role of presence and intention is needed (Yung *et al.*, 2021b). Experiences with a strong sense of presence in the pre-purchase stage closely resemble actual experiences, and these anticipatory experiences can influence the actions of potential visitors (Orús *et al.*, 2021). Drawing on presence theory, we expect VR for tourism simulations to enable potential visitors to experience realistic virtual tours of destinations, potentially increasing their likelihood of visiting those places in real life and talking about them with others. Formally, we propose our last hypotheses:

H5a. Presence increases the intention to visit the promoted destination.

H5b. Presence increases the intention to recommend the promoted destination to others.

We report our proposed model in Figure 1.

3. Methodology
3.1 Research design and stimuli
To test the proposed hypotheses, we developed a laboratory experiment investigating tourists' responses to a 360-degree virtual tour showcasing a real travel destination. The selected visual stimulus consisted of a 3-min movie with the most famous attractions in Valencia (Spain). We employed a one-factor between-subject design, where the medium technology was manipulated by randomly assigning participants to interact with the content via either HMD technology (360-degree VR condition) or on a stationary monitor (2D desktop condition). Those in the 360-degree VR condition were equipped with a Meta Quest 2 VR headset. Conversely, participants in the 2D desktop condition were exposed to the stimulus on a 24-inch desktop screen, with the video played in full-screen mode. The stimulus remained unaltered across the two conditions; hence, exposure time in both treatments was the same.

3.2 Procedure
Upon arrival at the experimental facility, participants were briefed on the study's objective, namely assessing the impact of immersive technologies on consumers within the context of destination tourism. They were then fitted with a galvanic skin response measurement device (Shimmer3 GSR+) placed on the distal phalanges of the hands of each participant, and informed consent was gathered. Before proceeding, participants completed a preliminary survey gathering sociodemographic data, previous experience with the destination,

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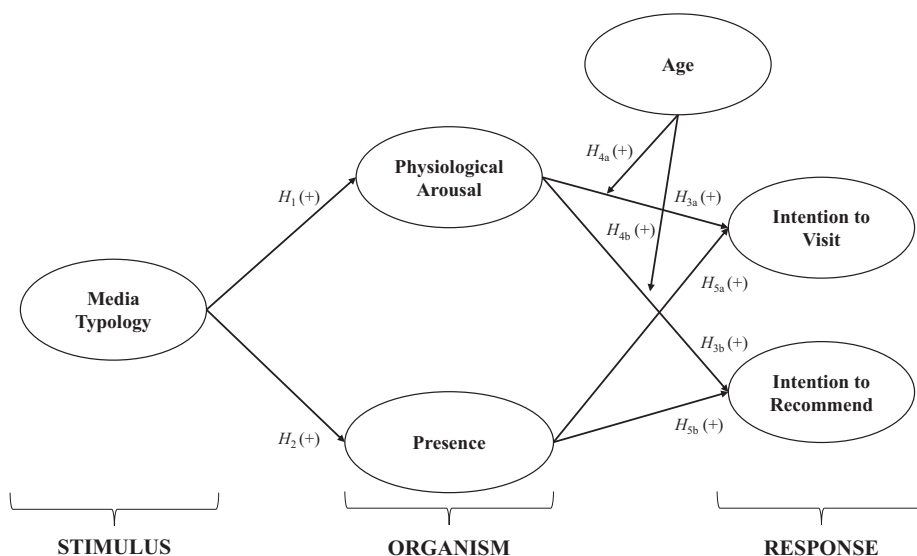
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Figure 1. Hypotheses tested in the model

360-degree videos, and media technology. This was made to account for possible confounding variables. Then, participants were presented with an introductory trial session. The purpose of this brief trial session was twofold: firstly, to familiarize participants with the interaction mechanics, and secondly, to isolate the potential wonder effects experienced by those trying the VR headset for the first time, which could have influenced participants' physiological responses. Next, the main stimulus was presented. Upon its conclusion, participants were asked to complete a closing questionnaire to assess their sense of presence, intention to visit, and intention to recommend the promoted destination.

3.3 Measures
All the self-reports were measured using a seven-point Likert scale, ranging from 1 (Strongly disagree) to 7 (Strongly agree). Previous experience with the destination, 360-degree videos, and media technology use were assessed with a single-item question and analyzed as binary variables. Presence was measured as a second-order construct, including eight items from the sub-constructs of self-location and possible actions (Vorderer *et al.*, 2004). Measurement scales for the intentions toward the destination were adapted from previously validated scales found in the tourism literature, with modifications made to fit the destination of the current study. Four items were adapted from the behavioral engagement scale (Flavián *et al.*, 2021) to target the intention to recommend after exposure to the virtual content. Intention to visit was measured by a three-item scale targeting behavioral intention to visit the promoted destination after the exposure, adapted from previous studies in the tourism field (Maghrifani *et al.*, 2022).

   Physiological arousal was measured by analyzing the galvanic skin response using iMotions' peak detection algorithm (v9.3.21, www.imotions.com/), in line with Benedek and

Kaernbach (2010). This process involved filtering the raw signal to isolate the phasic component, using a median filter with an 8,000 ms time window. A low-pass Butterworth filter with a cutoff frequency of 5 Hz was employed to remove signal noise. The algorithm was used to identify the onset and offset of potential arousal responses, with each pair marking a period within which the highest signal value is considered a potential peak. This was then accounted as a peak if its amplitude exceeded 0.005 µS and the duration between the onset and offset was above 500 ms. The metric of physiological arousal was assessed as the number of peaks in the phasic signal of individuals' electrodermal activity during the virtual experience. This metric has been widely used in previous investigations evaluating the emotional impact of 360-degree videos (Ausin-Azofra et al., 2021; Bolinski et al., 2021).

4. Results

4.1 Sample
A total of 187 participants aged between 18 and 38 (45.5% female, $M_{age} = 27.59$, $SD_{age} = 5.03$) participated in the experimentations. Participants were recruited by a specialized agency and received economic compensation for their participation. Although college students have been largely considered leading users of emerging technologies (Flavián et al., 2021), recent statistics indicate that VR technology's adoption transcends younger demographics, illustrating a significant engagement among Generation Y consumers (National Research Group, 2022). Furthermore, young student samples do not necessarily represent a good proxy of the general population of travelers (Griffin et al., 2023). Along these lines, we employed a balanced distribution across three different age categories to explore the moderating effect of age in our model, as reported in the Appendix 1. Participants were randomly assigned to one of the two treatments of the experiment, ensuring comparable sociodemographic characteristics across the conditions. The two experimental groups did not differ in terms of gender [$\chi^2(1, 187) = 0.316$, $p = 0.339$], age [$F(1, 186 = 0.062$, $p = 0.803$], previous experience with the destination [$\chi^2(1, 187) = 0.015$, $p = 0.517$], 360-degree videos [$\chi^2(1, 187) = 0.602$, $p = 0.265$] and media technology used [$\chi^2(1, 187) = 0.114$, $p = 0.424$], indicating successful randomization of the sample. Full statistics for the two experimental groups are reported in the Appendix 2.

To assess the influence of possible confounding variables related to age, we ran a one-way ANOVA with age as the continuous variable and previous experience with VR technology videos as the factor, and the test was not significant [$F(1, 186 = 0.000$, $p = 0.998$]. Indeed, younger segments are usually more prone to adopt novel technologies (Ahn et al., 2008). However, this result indicates that possible moderating effects of age cannot be attributable to a lack of experience with immersive technologies of older individuals.

4.2 Test of the measurement model
A data analysis was conducted using Partial Least Square (PLS) to test our hypotheses. This methodology has been deemed appropriate for our research objectives, considering that our model encompasses reflective constructs and single measures (Hair et al., 2021a). To confirm our structural model's suitability, we employed indicators and internal consistency reliability, convergent validity, and discriminant validity, as shown in Appendix 3 and Appendix 4.

Media typology was included in the model as a binary variable (0 for 2D desktop condition, 1 for 360-degree VR). The number of peaks extrapolated from the EDA signal during the 3-min time horizon ($Range_{physio} = [0; 44]$, $M_{physio} = 17.01$, $SD_{physio} = 12.57$) was included in the structural model as a normalized single-item measurement.

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4.3 Test of the structural model

First, we computed variance inflation factor (VIF) values for all the predicting variables, which were below 3 (VIF_{physio} = 1.109; $VIF_{presence}$ = 1.137; VIF_{age} = 1.095). Therefore, multi-collinearity was not an issue in our model (Hair *et al.*, 2021a). The results of the structural model are reported in Table 1. Media typology significantly affected arousal activation (β = 0.658, $p < 0.001$) and the perception of presence (β = 0.280, $p < 0.001$), thus supporting H_1 and H_2. Notably, the impact of media type on physiological arousal is far more pronounced than its effect on presence. As for the moderation analysis, we employed the two-stage method proposed by Chin *et al.* (2003). This methodology is recommended for its goodness in terms of parameter recovery and statistical power (Becker *et al.,* 2018). When running the model without age as a moderator to estimate the main effects, we found a positive, significant influence of physiological arousal on the intention to recommend the destination (β = 0.235, $p < 0.001$) but not on the intention to visit (β = 0.067, $p > 0.05$). However, when considering age as a moderator, we found significant interaction terms for both behavioral outcomes. In particular, the interaction term has a positive, significant effect on the intention to visit (β = 0.274, $p < 0.001$) and recommend (β = 0.240, $p < 0.001$). Therefore, we conclude that age has a significant, positive moderating effect on the relationship between physiological arousal and intention to visit and to recommend the destination. The moderating effect appears to be stronger for the intention to visit, as represented by the f^2 values (Table 1). Graphic representations of the slope analysis for both outcomes are reported in Appendix 5. Considering an average effect size in moderation tests of 0.009, these values indicate a large moderating effect (Hair *et al.*, 2021b). Based on these findings, we accept H_3 and H_4. Finally, we found a positive, significant effect of presence on intention to visit (β = 0.292, $p < 0.001$) and to recommend (β = 0.326, $p < 0.001$), thus supporting H_5 and H_6.

5. Conclusion and discussion

5.1 Conclusion

The objective of this study was twofold. First, to assess the influence of immersive media on the intention to visit the destination and the likelihood of recommending it after VR exposure by analyzing the mediating role of physiological arousal and presence. Second, exploring

Table 1. Results of the structural model

Effect	β	T stat. (bootstrap)	f^2
Media Type → Physiological Arousal	0.658	14.025***	0.762
Media Type → Presence	0.280	4.273***	0.085
Physiological Arousal → Intention to Visit *(main effect)*	0.067	0.880[ns]	0.005
Physiological Arousal → Intention to Recommend *(main effect)*	0.235	3.516***	0.065
Physiological Arousal → Intention to Visit *(simple effect)*	0.112	1.548[ns]	–
Physiological Arousal → Intention to Recommend *(simple effect)*	0.243	3.408**	–
Physiological Arousal × Age → Intention to Visit	0.274	4.208***	0.081
Physiological Arousal × Age → Intention to Recommend	0.240	3.874***	0.064
Age → Intention to Visit	0.209	3.034**	–
Age → Intention to Recommend	−0.035	−0.522[ns]	–
Presence → Intention to Visit	0.292	4.004***	0.098
Presence → Intention to Recommend	0.326	4.247***	0.124

Notes: [ns]not significant; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. R^2(Physiological Arousal) = 0.433; R^2(Presence) = 0.078; R^2(Intention to Visit) = 0.234; R^2(Intention to Recommend) = 0.250. Bootstrapping procedure with 5,000 samples

how users' age can generate a differential impact of immersive experiences on their effectiveness in destination tourism. Our results show that physiological arousal and presence significantly depend on the medium to access the experience. Still, immersive technologies appear to exert a significantly stronger impact on individuals' emotional reactions. This substantiates the notion that VR platforms are essentially affective media (Riva *et al.*, 2007), underscoring the necessity of forthcoming research in destination marketing to explore further the possible major impact of emotional reactions over rational deliberations. Interestingly, we observed a limited explanatory power of the technology medium on the sense of presence. As previously discussed, this is consistent with previous studies that suggest the sense of presence perceived by individuals does not depend solely on media characteristics.

However, presence is the variable that has the greatest impact on intentions. This finding underscores the notion that, despite immersive media's capacity to provoke significant emotional engagement, intentions are ultimately shaped by cognitive rationalization rather than affective reactions to the experience. This is particularly notable considering that this effect holds irrespective of the target audience's age. Also, although the relationship between immersion and presence is well-documented, emotional engagement has frequently been conceptualized as an outcome of presence in tourism literature (Yung *et al.*, 2021a). In line with foundational cognition-arousal theories (Reisenzein, 2017), our study shows how emotional activation measured through physiological arousal and the sense of presence are governed by distinct systems, with both having the capacity to influence decision-making.

Furthermore, upon examining our sample without accounting for age differences, we observe that presence significantly enhances both the intention to visit the destination and the creation of positive word-of-mouth. In contrast, physiological arousal only increases the intention to recommend the destination among potential visitors. This result is in line with previous contributions in the literature showing that affective destination image is more connected to the generation of word-of-mouth rather than travel intentions, given that individuals express emotional bounds with a place through conversational narrative exchanges (Bigné Alcañiz *et al.*, 2009; Griffin *et al.*, 2023). Yet, when age differences are considered, the moderation analysis shows a crossover effect, with physiological arousal influencing the intention to visit as well. Previous works propose that immersive media may evolve into viable substitutes for real destinations (Fan *et al.*, 2022). In particular, although tourists may encounter relevant emotional experiences while in a destination, they may prefer to explore new places in the future rather than visit the same destination promoted in the virtual experience (Marasco *et al.*, 2018). Our results suggest that this is even more pronounced when decision-makers attribute more importance to knowledgerelated goals, namely objectives that optimize the future of individuals (Fung and Carstensen, 2003). Nonetheless, these tourists may still be inclined to share their positive experiences and recommend the destination to friends or relatives (Quynh *et al.*, 2021).

5.2 Theoretical implications
The results of the study enrich the current literature in several ways. First, our study extends prior findings in destination marketing that have emphasized the potential of immersive media to elicit stronger emotional responses (Yung *et al.*, 2021a) by introducing and testing an objective metric of physiological arousal. In doing so, we also offer a significant methodological contribution by responding to recent calls to incorporate psychophysiological measures to mitigate potential biases associated with self-reported data (Martínez-Molés *et al.*, 2021; Tussyadiah *et al.*, 2018; Yung *et al.*, 2021a).

Second, we investigated the influence of physiological arousal and presence reported during VR exposure on behavioral outcomes. Recent research has cast doubt on the conversion potential of immersive technologies, indirectly suggesting that they are more effective at creating positive word-of-mouth experiences and enhancing the destination's appeal rather than fostering the intention to visit (Griffin et al., 2023). We contend this perspective by demonstrating how immersive technologies can generate differentiated outcomes from individuals while explaining the mechanisms behind these responses. To the best of our knowledge, this is the first study investigating the capacity of a physiological arousal metric to explain behavioral outcomes within the tourism field. Concurrently, we also advocate for the appropriateness of employing physiological measures in the context of VR tourism, as they demonstrate the capability to predict the behavioral responses of individuals after VR exposure accurately.

Third, the postulation of a direct impact of presence on behavioral intentions has remained largely discussed due to the limited empirical investigations (Yung et al., 2021b) and conflicting results (Choi et al., 2016; Kim et al., 2022; Lee et al., 2020; Martínez-Molés et al., 2021; Orús et al., 2021; Yung et al., 2021a). By testing these relationships in a novel context, we shed light on how the sense of presence can affect tourists' intentions to visit and recommend a destination. Our findings showed that presence significantly mediates both the intention to visit and the intention to recommend the promoted venue. This aligns with previous findings identifying presence as a crucial mediating factor between the experienced stimuli and behavioral intentions (Lee et al., 2020; Martínez-Molés et al., 2021; Orús et al., 2021).

To conclude, this research applied the socioemotional selectivity theory (Carstensen et al., 1999) to explain how age can influence the impact of immersive technologies on tourism advertisement effectiveness for the first time. In doing so, we emphasize the expanding market reach of VR applications beyond their traditionally younger user base and the need for future research to consider this broader acceptance and integration of immersive technologies across various age groups.

5.3 Practical implications

Previous studies have underscored the potential of VR as a marketing tool to enhance tourism experiences. Our paper supports this idea, demonstrating a compelling use case for immersive technologies, particularly through 360-degree videos. We suggest that incorporating immersive technology into the sales processes of travel agencies and destination marketing organizations (DMOs) can offer tangible benefits. For instance, travel agencies can use 360-degree videos to provide potential customers with virtual tours of destinations, offering them convincing pre-visit experiences generating strong emotional engagement and making them more likely to book a trip. In parallel, we demonstrated how immersive experience can foster a strong connection with the destination, encouraging them to advocate for the destination to others. This indirect advantage enhances word-of-mouth marketing and attracts new clients to the destination.

Also, our findings indicate that while immersive media can generate significant emotional engagement, it is the cognitive rationalization of being at the destination that primarily shapes individuals' intentions. Thus, merely leveraging the emotional impact of immersive media to create captivating and memorable experiences is not sufficient to attract visitors. We also showed how potential visitors need to feel as though they are genuinely present at the destination to solidify their travel intentions. In parallel, immersive experiences should strategically incorporate high-quality scenarios, realistic visuals, spatial audio, interactive features and convincing storytelling. Pursuing this integrated approach is essential to maximizing VR's effectiveness as a tool in tourism and hospitality management.

Finally, we highlighted the importance of age in shaping differential responses from individuals. Compared to Millenials, Gen Z individuals turn out to be less influenced by the

arousing aspect of the experience when deciding the travel destination, and the use of emotion-driven experiences may even generate detrimental effects. This finding underscores the necessity for practitioners in the field of destination marketing to adopt a segmented approach in their VR marketing strategies, taking into account the distinct preferences and responses of different age groups. For instance, practitioners should prioritize experiences based on storytelling that emphasizes a destination's uniqueness, cultural richness and educational value when targeting young people. For Millennials, creating emotionally charged content can drive individuals to desire immediate gratification after the experience, thus being a more effective promotional tool.

5.4 Limitations and future research

This study has certain limitations. First, we only focus on one emotional dimension to evaluate the affective outcomes of immersive technology, namely arousal (Russell, 1980). Future investigations may include a combination of valence and arousal to assess the impact on presence and the two behavioral outcomes considered, also based on neurophysiological measures. Furthermore, it is worth noting that physiological arousal can be evaluated using various metrics, encompassing peak amplitude, ISCR (Integrated Skin Conductance Response), and pure EDA signal. Although the number of peaks remains a widely employed metric for assessing arousal during VR exposure, it is advisable for future studies to replicate results by incorporating diverse measures of arousal to ascertain the most reliable and comprehensive indicators. Finally, given the relatively young destination target of immersive VR technology for tourism, we adopted a limited age span in our study. Future studies may find stronger effects of age when considering older people in similar contexts.

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Appendix 1

Table A1. Characteristics of participants

Characteristics	Frequency	%
Gender		
Female	85	45.5
Male	102	54.5
Age (years)		
18–24	66	35.3
25–29	62	33.1
30+	59	31.6
Education		
Less than high school	9	4.8
High school graduate	48	25.7
Bachelor's degree	73	39.0
Master of science	57	30.5
Previous experience with destination		
No	134	71.7
Yes	53	28.3
Previous experience VR		
No	96	51.3
yes	91	48.7
Previous Experience 360-videos		
No	84	44.9
Yes	103	55.1
Source: Authors' own creation		

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Appendix 2

Table A2. Demographics and previous experience across the two experimental conditions

	VR ($n = 96$)		Desktop ($n = 91$)	
	Frequency	%	Frequency	%
Gender				
Male	52	54.1	50	54.9
Female	44	45.8	41	45.1
Mean age	27.71		27.46	
Experience with destination				
Yes	26	27.1	27	29.7
No	70	72.9	64	70.3
Experience with VR				
Yes	49	51. 0	47	51.6
No	47	49.0	44	48.4
Experience with 360-degree tour				
Yes	59	61.5	50	55.0
No	37	38.5	41	45.0

Source: Authors' own creation

Appendix 3

Table A3. Items employed and psychometric properties of the constructs involved

Measurement items	Factor loadings
Presence: Self-location (SPSL)	
Vorderer *et al.* (2004) *α = 0.848; CR = 0.899; AVE = 0.691*	
I felt like I was actually there in the environment of the presentation	0.872
It was as though my true location had shifted into the environment in the presentation	0.745
I felt as though I was physically present in the environment of the presentation	0.907
It seemed as though I actually took part in the action of the presentation	0.791
Presence: Possible Actions (SPPA)	
Vorderer *et al.* (2004) *α = 0.897; CR = 0.927; AVE = 0.761*	
I had the impression that I could be active in the environment of the presentation	0.872
I felt like I could move around among the objects in the presentation	0.745
The objects in the presentation gave me the feeling that I could do things with them	0.907
It seemed to me that I could do whatever I wanted in the environment of the presentation	0.792
Intention to Recommend (ITR)	
Adapted from Flavián *et al.* (2021) *α = 0.873; CR = 0.914; AVE = 0.727*	
I would, after the virtual tour experience, probably say positive things about Valencia	0.806
After the virtual tour experience, I would be willing to recommend Valencia to those planning to visit Spain	0.902
It is likely I would, after the virtual tour experience, recommend Valencia to friends and relatives interested in visiting Spain	0.904
I would, after the virtual tour experience, seldom miss an opportunity to tell others interested in visiting Spain about Valencia	0.807
Intention to Visit (ITV)	
Adapted from Maghrifani *et al.* (2022) *α = 0.860; CR = 0.916; AVE = 0.784*	
After the virtual tour experience, I intend to visit Valencia within the next 12 months	0.938
After the virtual tour experience, I want to visit Valencia	0.802
After the virtual tour experience, it is likely that I will visit Valencia in the next 12 months	0.912
Source: Authors' own creation	

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Appendix 4

Table A4. Discriminant validity assessment using HTMT (heterotrait-monotrait) ratio criterion

Variable	Media type	Physiological arousal	Presence: Self location	Presence: Possible actions	Age	Intention to visit
Physiological arousal	0.658	–				
Presence: Self location	0.335	0.307	–			
Presence: Possible actions	0.196	0.145	0.857	–		
Age	0.024	0.133	0.138	0.301	–	
Intention to visit	0.228	0.163	0.438	0.338	0.246	–
Intention to recommend	0.272	0.336	0.484	0.310	0.022	0.722

Notes: All the values are below the threshold of 0.85, apart from HTMT value between the two components of Presence (Possible Actions and Self Location). However, this value is still acceptable, given that for conceptually similar constructs a threshold of 0.90 is usually adopted (Hair *et al*., 2021a, 2021b)
Source: Authors' own creation

Appendix 5
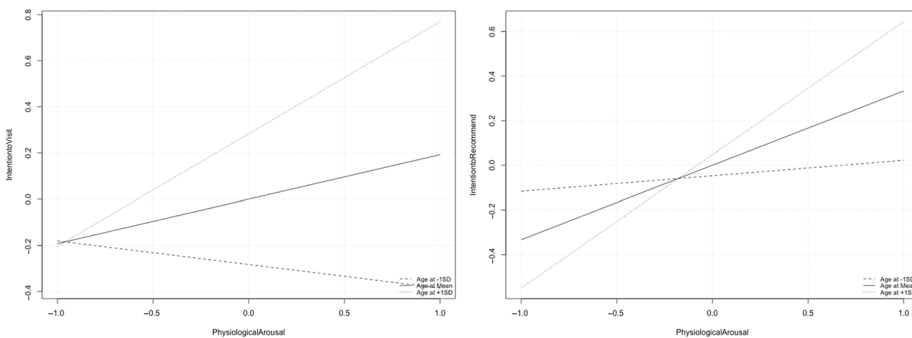
 Source: Generated using the seminr package in RStudio
Figure A1. Slope analysis for the moderation effect of age on the relationship between physiological arousal and intention to visit (left) and intention to recommend (right)

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