Impacts of technological embodiment through virtual reality on potential guests' emotions and engagement

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Virtual reality technologies have increased the integration between devices and the human senses. Despite the increased interest in embodied technologies in tourism, there has been little research into the effectiveness of virtual reality, particularly in the hospitality sector. The aim of the present work is to analyze the impact of technological embodiment on potential guests' emotional reactions and engagement in the context of a hotel-based virtual reality experience. Results from a laboratory experiment showed that, compared to desktop computers and mobile phones, virtual reality devices evoke more positive emotional reactions and higher levels of psychological and behavioral engagement. In addition, emotions and psychological engagement mediate the impact of embodied virtual reality devices on behavioral engagement. The results underline the importance of technological embodiment in providing engaging hotel-based pre-experiences, where the hotels incorporate virtual reality into their communication strategies.

Keywords: virtual reality; technology-mediated experience; technological embodiment; emotions; psychological engagement; behavioral engagement.

Introduction

Recent technological developments are dramatically changing the consumer's experience of products and services, especially in tourism and hospitality, where the implementation of cutting-edge technologies offering high-value propositions has a long history (Hudson, Matson-Barkat, Pallamin, & Jegou, 2018). The specific characteristics of this industry (service-based, experiential nature, impossible to test in advance; Guttentag, 2010; Scott, Laws, & Boksberger, 2009) make it suitable for the application of new technologies to support tourist experiences (Buhalis et al., 2019; Neuhofer, Buhalis, & Ladkin, 2014). Virtual Reality (VR) is an important technology in the provision of these high-value tourism propositions (Yung & Khoo-Lattimore, 2017). In VR experiences users are immersed in 3D virtual environments, where they can navigate and, possibly, interact, which triggers sensory stimulation (Guttentag, 2010). VR is a disruptive technology with the potential to transform the travel industry and the overall tourist experience (SimpleView, 2019). In addition, the development of mobile technologies and connections (i.e. 5G) will enable the real-time transmission of richer information, and facilitate the mass adoption of VR technologies (Forbes, 2019). Focusing on the hotel industry, a recent report showed that 66% of potential guests agreed that taking virtual tours using VR devices would help them in their decision-making processes (Oracle, 2017), which reinforces the impact of VR on the future of the sector.

Previous studies have called for further analysis of the use of VR in hospitality settings (Wei, 2019). The literature analyzing the impact of VR on tourism has focused on destinations (e.g. Tussyadiah, Wang, Jung, & tom Dieck, 2018), museums (e.g. Errichiello, Micera, Atzeni, & Del Chiappa, 2019), heritage sites (e.g. Marasco, Buonincontri, van

Niekerk, Orlowski, & Okumus, 2018) and theme parks (e.g. Wei, Qi, & Zhang, 2019). However, little empirical research has analyzed the effectiveness of VR in the hotel industry (see Bogicevic, Seo, Kandampully, Liu, & Rudd, 2019 for an exception). Camilleri (2018) argued that accommodation is a fundamental element in any travel or tourism decision, whereas attractions (e.g. museums and heritage sites) are considered ancillary products; tourist experiences with hotels usually last longer, entail higher financial commitment and, in some cases, include a wider range of activities than other products. Therefore, selecting a good hotel involves higher uncertainty and perceived risk (Sun, 2014). In addition, hotel experiences are dominated by instrumental value (Prebensen & Rosengren, 2016). Hence, the information search stage can be especially important and add value to the overall purchase journey for hotels, compared to other tourism activities dominated by hedonic value (e.g. viewing a tourist attraction).

VR technologies can help create effective hotel marketing experiences (Buhalis et al., 2019). These technologies can be applied to engage consumers during all stages of the customer journey (Bec et al., 2019; Flavián, Ibáñez-Sánchez, & Orús, 2019a) and offer valuable overall experiences. In the pre-experience stage, VR might inspire potential guests by conveying a realistic preview of how the real experience would, in the event, turn out (Neuburger, Beck, & Egger, 2018), thus reducing the perceived uncertainty and risk of purchasing the hotel product (Bogicevic et al., 2019). In addition, VR can be implemented during the experience stage of the journey (Errichiello et al., 2019), for instance by immersively providing information about tourism activities, or be offered as a form of escapism while guests are resting in their rooms. Finally, guests might record 360-degree videos of their hotel experience and later share it with others who might, thereafter, view it in a VR pre-experience and, as a result, opt for that specific hotel. The present study focuses on the pre-experience stage of the customer journey (Lemon & Verhoef, 2016), as when consumers research essentially intangible experiential products (e.g. hotels), they perform exhaustive information searches to support their decision-making (Gursoy, Bonn, & Chi, 2010; Gursoy & McCleary, 2004; Mohammed & Al-Swidi, 2019). In this way, VR might allow potential guests to obtain try-before-you-buy experiences that show how it would be to stay in the real environment (Kim & Hardin, 2010; Tussyadiah et al., 2018), empowering them in their decision-making processes (Binkhorst & Den Dekker, 2009).

New VR devices are characterized by a high level of integration with their users' bodies, being deeply fused with the human senses, and shaping user behavior (Tussyadiah, Jung, & tom Dieck, 2017; Verbeek, 2015). Technological embodiment occurs when the technology mediates the user's experience by becoming integrated into his or her body. Although this integration is one of its main features (Tussyadiah et al., 2017), no previous studies have empirically tested this technological feature of VR, nor analyzed the mechanisms through which technological embodiment affects the customer experience in the hotel industry. In addition, while the role of engagement has been emphasized in previous theoretical proposals about VR in the tourism and hospitality sector, there is a paucity of empirical studies on this emerging topic (e.g. Bec et al., 2019; Loureiro, Guerreiro, & Ali, 2020). The present study analyzes the affective process by which technologies, with different levels of embodiment (VR headsets, smartphones, and desktop computers; Flavián et al., 2019a), can be effective in the hotel pre-experience stage. Specifically, we examine the impact of technological embodiment on emotional reactions and its subsequent effects on psychological and behavioral engagement. The results from this research shed light on the affective processes underlying the effectiveness of VR devices in the hospitality sector, focusing on the role of technological embodiment. For practitioners, this research shows how hotel services' providers (e.g. hotel websites, travel agencies, booking websites), through offering high-value VR-based propositions, can create emotional and engaging ways of promoting their products.

Theoretical development and hypotheses

The impact of VR on technological embodiment and emotions

The arrival of new devices characterized by being increasingly embedded into the human body has altered human-technology mediation processes (Tussyadiah et al., 2017). As the technology evolves, it is expected that it will be increasingly integrated into human bodies, and become unnoticeable (e.g. merged devices, such as smart contact lenses), and reach a state of human-technology symbiosis (Verbeek, 2015) through which humans' capacities will be enhanced (Raisamo et al., 2019).

The theory of technological mediation (Ihde, 1990) aims to explain human-technology mediation processes. This theory describes embodiment as a state in which users' experiences are mediated by technological devices which become intertwined with their bodies and allow them to perceive, interpret and interact with their immediate environment (Tussyadiah et al., 2017). Following this theory, the National Research Council (2012) classifies technologies ranging from no, or minimum, embodiment (stationary external devices, e.g. desktop computers), to fully integrated devices (implanted devices, e.g. smart contact lenses). Technologies are classified on this continuum based on their level of technological embodiment. This taxonomy is further developed in the

Embodiment-Presence-Interactivity Cube (EPI Cube; Flavián et al., 2019a), which regards technological embodiment as the degree of contact between the device and the human senses. In this classification, external devices (detached from the human body) are distinguished from internal devices (fused with human senses). Taking stationary external devices as the lowest level of technological embodiment, portable examples (e.g. smartphones) are placed in the medium-low part of the continuum, and wearables (e.g. VR headsets), which are more physically integrated with the users' bodies, occupy a medium-high position. The maximum level of technological embodiment is achieved when the technology and the human body are fully integrated, forming the same entity (Tussyadiah et al., 2017). While these theoretical conceptualizations exist, there is a lack of empirical research that directly considers the degree of integration of the technologies with the human senses, and their subsequent impact on the user experience. Thus, the first hypothesis aims to empirically confirm this conceptual taxonomy. Specifically, it is expected that users will perceive VR headset devices (high embodiment) as more embodied than smartphones (medium) and desktop computers (low). In addition, smartphones are expected to be perceived as more embodied than desktop computers:

H_1: VR headsets generate higher perceptions of technological embodiment than smartphones and desktop computers, and smartphones generate higher perceptions of technological embodiment than desktop computers.

Emotions have been defined as states or feelings that arise as reactions to experiences (Mehrabian & Russell, 1974). In the present study, emotional reactions are related to the sense of feeling positive emotions (delight, excitement, pleasure and arousal; Laros & Steenkamp, 2005). Experiencing positive emotions is paramount for generating satisfactory experiences with hospitality products (e.g. Lo, Wu, & Tsai, 2015), even in pre-consumption encounters with service providers (Wang & Beise-Zee, 2013). Thus, where companies design pre-experiences that foster potential guests' positive emotions, this can establish initial bonds between them and the potential guests and, thus, develop competitive advantage. In this way, as VR headsets are more embodied with the human senses, they may generate intense emotional processes through immersive and sensory experiences (Petit, Velasco, & Spence, 2019). In addition, embodied technologies (VR headsets) can generate higher emotional states than less-embodied devices (Kim, Lee, & Jung, 2020), as they more effectively transfer emotions during the virtual environment experience (Van Kerrebroeck, Brengman, & Willems, 2017a). Therefore, we expect a linear relationship between technological embodiment and emotional reactions. Specifically, embodied VR (high embodiment) devices will produce more positive emotions than smartphones (medium) and desktop computers (low), and smartphones (medium embodiment) will generate more positive emotions than desktop computers (low). Formally:

H_2: High vs. medium, and medium vs. low, levels of technological embodiment have a positive effect on emotional reactions.

The impact of technological embodiment and emotions on user engagement

Customer engagement has received considerable attention in the hospitality literature as a means of improving the customer experience (e.g. Bilro, Loureiro, & Guerreiro, 2019; Harrigan, Evers, Miles, & Daly, 2017; Li, Cui, & Peng, 2017; Romero, 2017). Wei (2019) carried out a literature review specifically into VR technologies and identified engagement as one key experiential dimension of VR/AR-related experiences in tourism and hospitality. However, empirical research into the influence of VR on engagement in tourism is scarce (for exceptions, Wagler & Hanus, 2018; Willems, Brengman, & Van Kerrebroeck, 2019) and, to the best of the authors' knowledge, no studies have analyzed the impact of VR on potential guests' engagement with a prospective hotel. The present study focuses on the generation of engagement at early stages of the customer journey, before the actual experience with the hotel or brand takes place. O'Brien, Cairns and Hall (2018) defined user engagement as the quality of an experience characterized by the user's cognitive, temporal, affective and behavioral investment when interacting in a virtual environment. The conceptualization of user engagement differs slightly from other forms of engagement, such as customer brand engagement or customer engagement (Harrigan et al., 2017; Hollebeek, Srivastava, & Chen, 2019).

User engagement can be analyzed from a psychological and a behavioral point of view (Fang, Zhao, Wen, & Wang, 2017; Romero, 2017). On the one hand, psychological engagement occurs through interactive customer experiences with a focal object (e.g. a VR pre-experience with a hospitality service provider) (Brodie, Hollebeek, Jurić, & Ilić, 2011). Bowden (2009) defined engagement as a psychological process that leads to customer retention and loyalty. O'Brien et al. (2018) adopted attribute-based user engagement in human-computer interactions to develop a multidimensional scale that included factors related to focused attention (i.e. feeling absorbed in the interaction), esthetic appeal (i.e. the attractiveness and visual appeal of the interface), and reward (i.e. degree of perceived interest and success of the interaction). On the other hand, behavioral engagement has been defined as the user's behavioral manifestations toward a focal object (e.g. brand, service provider) that go beyond purchase (Van Doorn et al., 2010). These behavioral manifestations include spreading word-of-mouth, and giving assistance and recommendations to others (Romero, 2017; Van Doorn et al., 2010). The present study adopts this dual perspective to analyze the impact of technological embodiment on users' pre-experiences with prospective hotels.

Regarding psychological engagement, previous theoretical developments have emphasized the potential of VR technologies to increase customer engagement in tourism and hospitality (Barnes, 2016; Bec et al., 2019), and have called for research into the topic (Loureiro et al., 2020). A few empirical exceptions, including Griffin et al. (2017), have found that VR devices (high embodiment) are more effective at promoting destinations, by engaging potential tourists, than 2D videos and websites (less embodied devices). Wagler and Hanus (2018) compared 360-degree video VR experiences to real-world experiences and showed similar levels of engagement. Willems et al. (2019) examined enjoyment, flow and purchase intentions as antecedents of engagement, and found that VR experiences are more effective than static images and 360-degree videos displayed on laptops. However, these empirical studies did not directly measure the impact of technological devices on psychological engagement. The present study proposes that, as degree of technological embodiment increases, the psychological processes through which the user becomes engaged in the experience will be strengthened. The integration between technologies and the human body may lead users to feel absorbed in their interactions (Tussyadiah et al., 2017), perceive the content viewed as highly appealing (Van Kerrebroeck, Brengman, & Willems, 2017b), and evaluate the experience as interesting and worthwhile (Tussyadiah et al., 2018; Wagler & Hanus, 2018).

This research operationalizes behavioral engagement as the users' intention to recommend a hotel (Berezina, Bilgihan, Cobanoglu, & Okumus, 2015; Getty & Thompson, 1995). Behavioral intentions can be considered as the main antecedent of actual behaviors (Ajzen, 1991), and previous studies have shown that behavioral intentions translate into actual behaviors (e.g. Casaló, Flavián, & Ibáñez-Sánchez, 2017a; Venkatesh & Davis, 2000). Intention to recommend consists of the generation of positive word-of-mouth that introduces a particular product to others (Casaló, Flavián, & Ibáñez-Sánchez, 2017b). Intention to recommend has been shown to be a key customer engagement behavior (Van Doorn et al., 2010), especially in tourism and hospitality (Bilro et al., 2019; Prayag, Hosany, & Odeh, 2013; Romero, 2017). Recommendations are among the most preferred and influential travel information and decision-making sources (Alves, Campón-Cerro, & Hernández-Mogollón, 2019; Berezina et al., 2015), given that hospitality products are difficult to evaluate before they are experienced (Bilro et al., 2019). In this sense, the application of embodied VR headsets is useful in tourism as they allow potential tourists to have "try-before-you-buy" experiences, which improves information diagnosticity by creating realistic images in their minds and fosters behavioral intentions (Tussyadiah et al., 2018). In other tourism contexts, such as destinations and museums, VR headsets have been shown to generate greater intention to share the experience on social media and recommend the tourist context to friends and family (Errichiello et al., 2019; Griffin et al., 2017). These effects can be extrapolated to the hospitality context.

Therefore, we expect that, compared to less embodied devices (smartphones and desktop computers), pre-experiences with highly-embodied devices (VR headsets) will result in higher levels of psychological and behavioral engagement. Similarly, medium levels of technological embodiment (smartphones) will produce higher levels of psychological and behavioral engagement than low levels of embodiment (desktop computers):

H_3: High vs. medium, and medium vs. low, levels of technological embodiment have a positive effect on (a) psychological engagement and (b) behavioral engagement.

In addition, this research attempts to establish that relationships including technological embodiment and emotional reactions can explain how experiences with VR headsets might, through the affective route, generate psychological and behavioral engagement. Specifically, users can experience a sense of psychological engagement (Mollen & Wilson, 2010), and develop greater intention to recommend products (i.e. behavioral engagement; Prayag et al., 2013), when they have enjoyed emotionally stimulating experiences. Previous research has established that, when customers feel an intense emotion during an online tourist experience, their degree of engagement increases (Bilro et al., 2019; Yeh, Wang, Li, & Lin, 2017). In technology-mediated environments, users who enjoy positive emotions when using VR in museums also showed positive intentions to share their experiences through online reviews and social media (Errichiello et al., 2019). With tourist destination pre-experiences, positive emotions and emotional involvement lead to positive behavioral engagement (Huang, Backman, Backman, & Moore, 2013). Therefore, as embodied VR devices stimulate consumers' emotions (Kim et al., 2020; Riva et al., 2007), we expect emotional reactions to mediate the impact of VR technologies on psychological and behavioral engagement:

H_4: Emotional reactions mediate the effect of high vs. medium, and medium vs. low, levels of technological embodiment on users' (a) psychological engagement and (b) behavioral engagement.

Finally, high levels of psychological engagement positively influence behavioral engagement (i.e. intention to recommend; Fang et al., 2017; Van Doorn et al., 2010). When users are psychologically engaged with the content they are viewing, they are prone thereafter to recommend that content to others (Oh & Sundar, 2016). This also occurs in hospitality services; companies that provide engaging experiences increase customers' willingness to recommend those experiences to others (Bilro et al, 2019). Furthermore, the effect of psychological engagement on behavioral engagement can be even stronger when users view the content through embodied VR devices (Wagler & Hanus, 2018). Therefore, if embodied VR devices are able to generate higher states of psychological engagement than less embodied devices, it is expected that users will be more willing to recommend the product displayed through the technology (Griffin et al., 2017). Thus:

H_5: Psychological engagement mediates the effect of high vs. medium, and medium vs. low, levels of technological embodiment on users' behavioral engagement.

Figure 1 depicts the research model and related hypotheses.

INSERT FIGURE 1 ABOUT HERE

Methodology

Data to test the hypotheses were collected in a laboratory experiment. The participants were college students (n = 141; 61.7% female; mean age = 20.62) studying at a Spanish public university; they received a course credit for their participation. College students are a valid and homogeneous group in terms of education levels and age (Flavián, Gurrea, & Orús, 2016). Previous VR research has mostly used student samples (Suh & Prophet, 2018). In fact, college students are considered to be the leading users of emerging technologies (Parboteeah, Valacich, & Wells, 2009) and seem to be especially interested in VR (Virtual

Reality Pop, 2018). The experiment was carried out during the period December 10th-14th, 2018.

The participants were asked to imagine that they were planning to visit Venice and that they were looking for accommodation. In the experiment, the participants were presented with a pre-experience of a real hotel room, in which they watched a 360-degree video with technologies with varying degrees of technological embodiment. The participants were first welcomed in a room where the researchers gave them a brief introduction to the study (context and instructions). Next, they answered a first questionnaire to gather information about several control variables: preference for city tourism (from 1 = "I do not like it at all", to 7 = "I like it very much"), their previous experience of Venice (yes vs. no), their previous experience with 360-degree videos displayed on desktop computers, smartphones and VR headsets (from 1 = "I have never used this device to watch these videos" to 7 = "I am very accustomed to use this device to watch these videos") and their level of technological innovativeness (six 7-point Likert items adapted from Bruner & Kumar, 2007; Thakur, Angriawan, & Summey, 2016; see appendix).

Second, the participants were randomly assigned to the experimental treatments: a pre-experience of a hotel room viewed through devices which varied in level of technological embodiment: low (desktop computers, PCs henceforth), medium (smartphones, SM henceforth), or high (VR headsets, VR henceforth). They were then directed to different rooms according to their experimental condition (47 participants per scenario, exceeding the recommended values proposed by Seltman, 2018). The participants then watched the same 360-degree video about a hotel room on their assigned device. The video showed some of the normal aspects of a hotel room (e.g. bed, desk, bathroom). After watching the content, the participants completed the second part of the questionnaire. This included scales previously validated in the literature, adapted to the study context (see appendix): technological embodiment (Flavián, Ibáñez-Sánchez, & Orús, 2019b), emotional reactions (Bigné, Andreu, & Gnoth, 2005), psychological engagement (O'Brien et al., 2018) and behavioral engagement (i.e. intention to recommend the hotel; Algesheimer, Dholakia, & Herrmann, 2005; Casaló et al., 2017b). Seven-point Likert scales were used for all the variables (from 1 = strongly disagree, to 7 = strongly agree), with the exception of emotional reactions, which used seven-point semantic differential scales (appendix).

Analysis and results

Before the hypotheses were tested, SmartPLS 3.0. was used to carry out a confirmatory factor analysis to validate the scales. The results showed that all the variables' items had higher loads than the recommended 0.7 benchmark (Henseler, Ringle, & Sinkovics, 2009), except for the fourth and sixth items of technological innovativeness, which were removed from the analysis. In addition, the Cronbach alphas were higher than 0.7 and the composite reliabilities exceeded 0.65 (Bagozzi & Yin, 1998; Steenkamp & Geyskens, 2006). Finally, the average variances extracted (AVEs) were superior to the 0.5 benchmark, and the square roots of the AVEs were greater than the inter-construct correlations, proving convergent and discriminant validity, respectively (Fornell & Larcker, 1981).

When the scales had been validated, the average values of the items were calculated to create the measures used in the analysis. We conducted one-way ANOVAs, with the different technologies as the independent factor. The descriptive statistics of the different experimental conditions and the results of the ANOVA are shown in Table 1. The results show that the experimental treatments had significant effects on all the variables under study. Post-hoc HSD Tukey tests allowed us to verify the significance of the differences between conditions. Specifically, the VR condition participants perceived a higher degree of technological embodiment than participants in the other conditions, and those in the SM group perceived higher embodiment than those in the PC group (Table 1). Thus, H_1 is supported.

In addition, the analysis showed that the VR condition participants reported significantly higher levels of emotional reactions, and psychological and behavioral engagement than the SM and PC participants. Furthermore, watching the 360-degree video on a SM led to significantly higher positive emotions and psychological engagement than watching it on a desktop PC; however, the difference between these two devices in terms of intention to recommend the hotel was not significant (Table 1). Altogether, we found support for H_2 and H_{3a}, whereas H_{3b} was only partially supported. Nevertheless, the VR headset was more effective for fostering behavioral engagement.

INSERT TABLE 1 ABOUT HERE

Taking into account the specific features of our research model (a non-recursive model with one multicategorical independent variable, one dependent variable and a causal path analysis with serial mediation), the PROCESS macro v3 for SPSS (Hayes, 2018) was used to test the mediating effects proposed in H_4 and H_5. Specifically, we ran a causal path model (model 6) to analyze the mediating effects of emotions and psychological engagement in the relationship between device type and behavioral engagement. Sequential coding was used to operationalize the multicategorical independent variable (Hayes, 2018).

Two dummy variables (X1: 0 = desktop PC, 1 = SM and VR; X2: 1 = VR, 0 = desktop PC and SM) were used to test the model. We included the control variables related to the destination (preference for city tourism and previous experience of Venice) and the technology (previous experience with the device and technological innovativeness) in the model. Table 2 shows the results of the analysis. Regarding control variables, we found that the participants' previous experience of the destination had a significant positive effect on emotions and intention to recommend, and that technological innovativeness had an overall negative effect on emotional reactions, and psychological and behavioral engagement. No other effects were significant (Table 2).

INSERT TABLE 2 ABOUT HERE

After controlling for these variables, the direct effect of the device on behavioral engagement disappeared when the mediators were included in the model. The results showed that emotional reactions positively influenced psychological engagement, and that the direct effect of the device on psychological engagement remained significant. In addition, psychological engagement had a significant influence on intention to recommend, whereas the effects of the device and emotions were not significant. The results of a bootstrap analysis, with 5,000 subsamples, undertaken to test the significance of the indirect effects (Table 2), showed that the paths Device – Emotional reactions – Psychological engagement – Behavioral engagement and Device – Psychological engagement – Behavioral engagement were significant. Therefore, H_{4a} and H_5 were supported, while H_{4b} must be rejected.

Discussion and conclusions

VR devices appear to be ideal technologies for offering try-before-you-buy experiences in tourism and hospitality, given that they allow potential guests to obtain valuable information from immersive experiences that helps them make better decisions (Bogicevic et al., 2019). However, empirical research has overlooked the role of VR in the hotel industry (Wei, 2019). This study aims to provide a better understanding of the underlying affective processes that take place when embodied VR devices engage potential guests in their hotel pre-experiences.

In this scenario, our findings revealed that, as degree of technological device/human body contact and integration increases, perceptions of technological embodiment are enhanced. Specifically, VR devices produced higher perceptions of embodiment than smartphones and desktop PCs, and smartphones produced higher perceptions of embodiment than stationary devices. These results empirically confirmed the different levels of technological embodiment proposed by previous conceptualizations (Flavián et al., 2019a; National Research Council, 2012).

The analysis showed that the level of technological embodiment has a strong, positive impact on users' pre-experiences. Specifically, VR devices generated more positive emotions than less embodied devices. This may be due to the immersive and sensorially enriching capacities of embodied VR devices (Petit et al., 2019). VR has been identified as an effective tool through which to induce feelings (e.g. relaxation; Riva et al., 2007), and which can generate pleasant experiences that help overcome negative situations (Van Kerrebroeck et al., 2017a). In tourism, Kim et al. (2020), using VR, showed the importance of emotional involvement in a wide variety of tourist experiences (e.g. overseas or domestic travel, recreation, leisure activities). However, no previous studies have directly compared the particular emotions that are aroused by VR experiences and other devices, nor analyzed the emotional impact of VR in hospitality settings. Our study measures, using different embodied devices, potential guests' specific emotional reactions during digital hotel pre-experiences; it was found that positive emotions increased as degree of technological embodiment increased.

In addition, embodied VR technologies had a positive impact on psychological and behavioral engagement. Despite being identified as one of the key dimensions in tourism experiences with VR (Wei, 2019), previous research in this context has been mainly theoretical (e.g. Bec et al., 2019). The few empirical exceptions (Wagler & Hanus, 2018; Willems et al., 2019) did not directly measure engagement. Thus, the role of engagement in VR experiences in the hotel industry remains unexplored. By adopting a dual perspective of engagement (psychological and behavioral dimensions; Fang et al., 2017; Romero, 2017), the present study showed that technological embodiment has a positive influence on psychological and behavioral engagement in a hotel-based digital pre-experience. Of the devices considered, VR headsets generate the highest levels of psychological and behavioral engagement.

Finally, the causal path analysis indicated that the emotional reactions obtained from the experience partially mediated the effect of the device (technological embodiment) on psychological engagement. Experiences with highly-embodied devices can generate high levels of engagement based on higher emotional connections with the content displayed (Barnes, 2016). However, our results showed that emotions did not directly mediate the effect of the device on intention to recommend the hotel; this effect was established indirectly through psychological engagement. Marasco et al. (2018) stated that emotional involvement, by itself, is not enough to generate higher behavioral intentions toward destinations, pointing out that indirect variables affect this relationship. Our findings indicated that users may need to be psychologically engaged in the virtual experience to generate a strong connection with the focal object (e.g. a hotel), which may then drive them to recommend the object to others. The results also confirmed the mediating effect of psychological engagement in the relationship between the device and behavioral engagement. Therefore, in line with Choi, Hickerson and Lee (2018), users may need to be psychologically engaged with the virtual experience to increase their behavioral intentions to recommend the content, particularly with embodied devices.

Theoretical and managerial implications

This research contributes to the still scarce research regarding the effectiveness of VR in the hotel industry (Wei, 2019), a sector which is characterized by the inherent intangibility of the product offering (Casaló, Flavián, Guinalíu, & Ekinci, 2015; Gómez-Suárez, & Veloso, 2020). Hotels, in comparison to other tourism products, represent a key element of any travel or tourism experience, and consumers derive mainly utilitarian value from their experiences with them (Camilleri, 2008; Prebensen & Rosengren, 2016). Thus, given that booking accommodation involves high risk, the information search process is especially important for consumers (Sun, 2014). New developments, such as VR technologies, represent a further step forward in addressing this challenge through offering tourists more realistic vicarious hotel-based experiences prior to them undergoing the real world experience (Bogicevic et al., 2019). Given the absence of research into the underlying processes taking place in VR tourism experiences, and in the hotel industry in particular

(Wei, 2019), our research contributes to a better understanding of the affective route that is followed when guests use these devices. Potential guests, thanks to VR devices, can obtain superior value propositions in their pre-experiences with hotels. In addition, while conceptual proposals have been made in this context (e.g. Flavián et al., 2019a; Ihde, 1990), they are unsupported by empirical research; thus, our findings empirically confirm the importance of technological embodiment in VR experiences for generating effective customer experiences. High levels of integration between the technologies and the human senses enhance the emotional reactions that arise during digital hotel-based pre-experiences.

Furthermore, although engagement is considered as a key variable in the VR in tourism and hospitality literature (Wei, 2019), it has been mostly addressed conceptually (e.g. Bec et al., 2019; Loureiro et al., 2020). The present study contributes to this flourishing topic by empirically analyzing the impact of VR on engagement from a dual perspective, that is, psychological and behavioral (Fang et al., 2017; Romero, 2017). In addition, we contribute to the engagement literature by examining the effects of this variable during the early stages of the customer experience, before actual interaction with the product, service or brand (Harrigan et al., 2017; Hollebeek et al., 2019). Our findings showed that embodied VR fosters psychological and behavioral engagement, and that a positive relationship exists between them. Both psychological and behavioral engagement should be considered in future research when analyzing how VR can be implemented in tourism and hospitality pre-experiences. Finally, behavioral engagement has been operationalized by means of intention to recommend the hotel. Previous research has proposed that a relationship exists between positive emotions and intention to share VR tourism experiences (Errichiello et al., 2019). We take a step further by empirically confirming this relationship in the context of a hotel-based VR pre-experience, both directly and indirectly through psychological engagement.

Regarding managerial implications, as marketers strive to find new ways of promoting their products through emotions (Hays, Page, & Buhalis, 2013), they should consider the impact of embodied VR devices. These technologies can generate emotionally stimulating and psychologically engaging experiences which, in turn, create positive behavioral engagement (i.e. intention to recommend). Hotel managers should, to create these experiences, take into account the content that their potential guests can view with embodied VR devices. Thus, they should be involved in the content creation process to ensure that fundamental requirements are met (e.g. high-quality recording and editing, interactivity, sensory inputs; Cowan & Ketron, 2019), which will enhance emotional reactions and levels of psychological and behavioral engagement. Importantly, potential guests' engagement with hotels may begin even before the real experience. For instance, the potential clients' emotions might be aroused through VR-based gamification experiences, during which potential guests could interact, performing different tasks, with different spaces within the hotel. Consequently, the users might feel psychologically engaged with the experience which, in turn, would lead them to recommend the hotel. As previous research has noted (Bilro et al., 2019; Errichiello et al., 2019), electronic word-of-mouth (eWOM) is a powerful tool that tourism and hospitality companies can use to generate competitive advantage, as it helps potential tourists in their decision-making processes.

By displaying engaging content through VR technologies, hotel managers can create memorable and effective pre-experiences to use in their communication strategies. In fact, although little research attention has been paid to the application of VR in the hotel industry, several hotel chains (e.g. Best Western Hotel & Resorts; Best Western, 2016) are using the technology to provide information about their hotel rooms, which highlights its potential in the hospitality industry. Hotel managers and booking websites might use VR to provide their customers with realistic pre-experiences to give them clear and vivid impressions of how the real experiences might turn out. Similarly, travel agencies could offer the technology in their stores to provide added-value services through which potential guests could easily imagine the hotels where they plan to stay. Thus, through embodied VR devices, potential guests can experience the rooms by themselves, thereby obtaining more information than from a mere description, or a regular video, and empowering them to make their final decisions.

Limitations and future research lines

This study has several limitations that could generate future research lines. First, the research was conducted under artificial conditions, that is, in a laboratory, to guarantee internal validity. In addition, the sample, made up of undergraduate business students, was rather small. College students are homogeneous in terms of education level and age, which increases the internal validity of the laboratory experiment (Flavián et al., 2016). Moreover, they represent a valid consumer group from the marketing perspective, and this youngest generation shows a great interest in VR technologies (Virtual Reality Pop, 2018). However, previous research has noted that socio-demographic characteristics (e.g. age, educational level) may influence attitudes toward, and perceptions of, VR experiences (Errichiello et al., 2019). Thus, future research should perform field studies (e.g. in travel agencies) with larger and more representative samples to compare the results across different types of individuals and increase external validity.

Second, the stimulus analyzed was one single room in a hotel chain viewed through different devices. Moreover, one single city (Venice) was used as the stimulus. It would be interesting to use different stimuli (e.g. different categories of room, such as low-cost, standard, premium), different hotel categories (e.g. hostels versus four-star hotels), in different destinations (e.g. cities versus rural areas) to compare, based on potential guests' responses, the effectiveness of the different technologies (e.g. intention to upgrade room category; Hotel Technology News, 2019). Third, emotional reactions and psychological engagement were assessed through self-reported measures. It would be interesting to collect both self-reported and neurophysiological measures of these constructs (Suh & Prophet, 2018).

As for future research lines, the present study has focused on the use of VR technologies in the pre-experience stage of the customer journey (Lemon & Verhoef, 2016). As VR technologies can be applied in all the stages of the journey (Flavián et al., 2019a), and some hotel chains are currently using them during their guests' stays (e.g. Marriott; Medium, 2018), further studies might analyze the use of VR devices during the experience stage. Finally, our analysis of the control variables showed that having previously visited the destination had a positive impact on emotions and behavioral engagement. This may be because users take their previous experience and memories into account when recommending hotels. In addition, technological innovativeness was found to have a negative effect on all the variables. It seems that, when the novelty of a device fades, technological innovators may become accustomed to their use (Rogers, 2010), and their effect may be reduced as the technology becomes commonplace (Flavián et al., 2019a). Future research should consider these issues and include personality traits (e.g. immersive tendency, capacity to imagine) to obtain a more complete understanding about the effectiveness of VR experiences.

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Appendix

Please rate from 1 (strongly disagree) to 7 (strongly agree) the extent to which you agree with the following sentences.

Technological innovativeness *(adapted from Bruner & Kumar, 2007; Thakur et al., 2016)*
I get a kick out of buying new high-tech items before most other people know they exist.
It is cool to be the first to own high-tech products.
I get a thrill out of being the first to purchase a high technology item.
Being the first to buy new technological devices is very important to me.
I want to own the newest technological products.
When I see a new technology in a store (web), I often buy it because it is new.

Please rate from 1 (strongly disagree) to 7 (strongly agree) the extent to which you agree with the following sentences regarding your hotel experience with (experimental condition; EC).

Technological embodiment *(adapted from Flavián et al., 2019b)*	
The (EC) technology is almost integrated into my body.	
The (EC) technology becomes part of my actions.	
The (EC) technology is an extension of my body.	
Emotional reactions *(adapted from Bigné et al., 2005)*	
During the (EC) experience, I felt…	
Disappointed (1)	Delighted (7)
Calm (1)	Excited (7)

Dissatisfied (1)	Very pleased (7)
Unaroused (1)	Aroused (7)
Psychological engagement *(adapted from O'Brien et al., 2018)*	
I lost myself in the (EC) experience.	
I was absorbed in the (EC) experience.	
The time I spent in the (EC) experience just slipped away.	
The (EC) experience was attractive.	
The (EC) experience was aesthetically appealing.	
The (EC) experience appealed to my senses.	
Using the (EC) in the experience was worthwhile.	
My experience with the (EC) was rewarding.	
I felt interested in the (EC) experience.	
Behavioral engagement *(adapted from Algesheimer et al., 2005; Casaló et al., 2017b)*	
After the (EC) experience, I would be willing to recommend the hotel to those planning to visit Venice.	
It is likely I would, after the (EC) experience, recommend the hotel to friends and relatives interested in visiting Venice.	
I would, after the (EC) experience, seldom miss an opportunity to tell others interested in visiting Venice about the hotel.	
I would, after the (EC) experience, probably say positive things about the hotel.	

Figure 1. Research model.

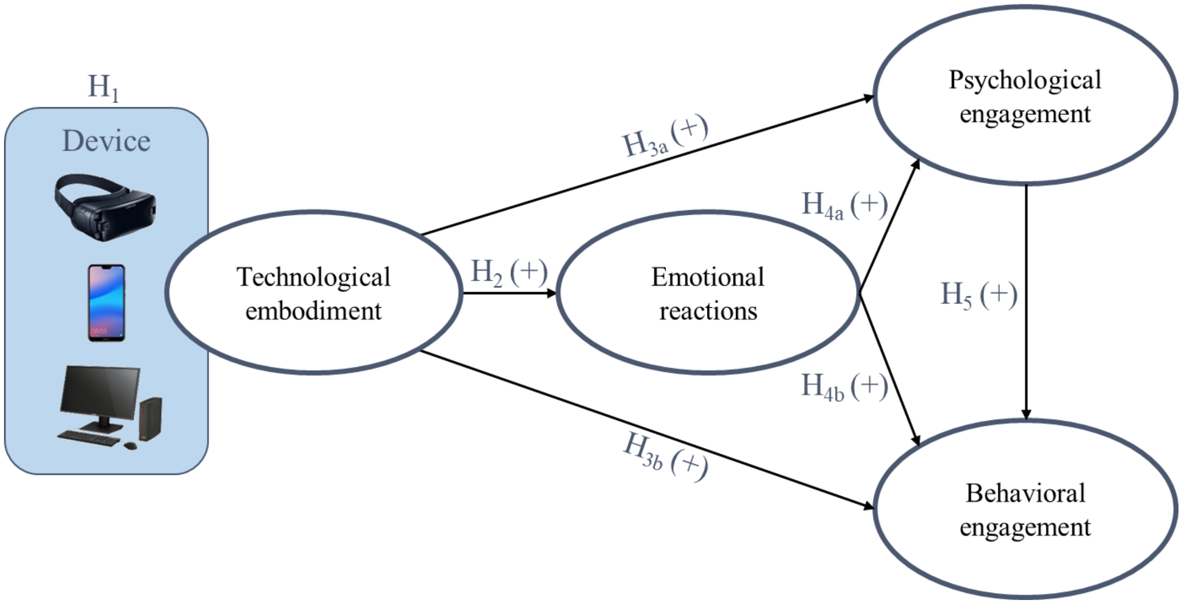

Table 1. Descriptive statistics and results of the ANOVA.

	VR		SM		PC		F(2, 138) (sign.)	Sign. Diff.*	Supported hypotheses
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**			
Technological embodiment	5.63	0.99	4.09	1.15	2.84	1.31	67.948 (0.000)	1-2; 1-3; 2-3	H_1
Emotional reactions	5.66	1.02	4.62	1.09	3.74	1.04	39.267 (0.000)	1-2; 1-3; 2-3	H_2
Psychological engagement	6.03	0.68	4.84	1.03	4.06	1.05	52.732 (0.000)	1-2; 1-3; 2-3	H_{3a}
Behavioral engagement	5.43	0.94	4.54	1.20	4.07	1.30	16.408 (0.000)	1-2; 1-3	H_{3b}

Note: F values correspond to the Brown-Forsythe test.
** Post-hoc Tukey tests. Experimental conditions: 1= VR condition; 2 = SM condition; 3 = Desktop PC condition. Differences significant at 95% level*

Table 2. Results of the analysis of the mediation model on intention to recommend.

Predictor	**Coeff.**	**SE**	***t***	***p***	**LLCI**	**ULCI**
Emotional reactions						
Constant	3.574	0.53	6.724	0.000	2.523	4.625
X1 (desktop PC vs. otherwise)	0.936	0.21	4.381	0.000	0.514	1.359
X2 (VR vs. otherwise)	0.945	0.23	4.151	0.000	0.495	1.396
Preference for city tourism	0.119	0.08	1.548	0.124	-0.033	0.271
Experience in the destination (Venice)	0.532	0.18	2.910	0.004	0.171	0.893
Experience with the device	-0.047	0.05	-0.867	0.388	-0.155	0.061
Technological innovativeness	-0.209	0.07	-3.187	0.002	-0.339	-0.079
Model Summary	**$R^2 = 0.446$; $F_{(6, 134)} = 17.987$, $p < 0.001$**					
Psychological engagement						
Constant	2.283	0.39	5.787	0.000	1.503	3.064
X1 (desktop PC vs. otherwise)	0.198	0.15	1.348	0.000	-0.092	0.488
X2 (VR vs. otherwise)	0.601	0.16	3.927	0.000	0.303	0.917
Emotional reactions	0.616	0.06	11.107	0.000	0.506	0.726
Preference for city tourism	-0.044	0.05	-0.885	0.378	-0.142	0.054
Experience in the destination (Venice)	0.104	0.12	0.858	0.392	-0.136	0.343
Experience with the device	0.032	0.04	0.912	0.363	-0.038	0.102
Technological innovativeness	-0.121	0.04	-2.764	0.007	-0.208	-0.034
Model Summary	**$R^2 = 0.746$; $F_{(7, 133)} = 55.824$, $p < 0.001$**					
Behavioral engagement						
Constant	1.792	0.68	2.623	0.009	0.441	3.143
X1 (desktop PC vs. otherwise)	0.114	0.23	0.499	0.618	-0.338	0.566
X2 (VR vs. otherwise)	0.269	0.25	1.059	0.291	-0.233	0.771
Emotional reactions	-0.107	0.12	-0.899	0.370	-0.343	0.129
Psychological engagement	0.589	0.13	4.394	0.000	0.324	0.855
Preference for city tourism	0.075	0.08	0.971	0.333	-0.078	0.228
Experience in the destination (Venice)	0.622	0.19	3.316	0.001	0.251	0.994
Experience with the device	-0.014	0.05	-0.249	0.803	-0.122	0.094
Technological innovativeness	-0.122	0.07	-1.748	0.083	-0.259	0.016
Model Summary	**$R^2 = 0.044$; $F_{(8, 132)} = 12.958$, $p < 0.001$**					
TOTAL EFFECT MODEL: Behavioral engagement						
Constant	4.053	0.58	7.021	0.000	2.911	5.194
X1 (desktop PC vs. otherwise)	0.471	0.23	2.027	0.045	0.012	0.929
X2 (VR vs. otherwise)	0.871	0.25	3.519	0.001	0.381	1.359
Preference for city tourism	0.079	0.08	0.952	0.343	-0.086	0.244
Experience in the destination (Venice)	0.819	0.19	4.129	0.000	0.427	1.212
Experience with the device	-0.007	0.06	-0.115	0.909	-0.124	0.111
Technological innovativeness	-0.247	0.07	-3.454	0.001	-0.388	-0.105
Model Summary	**$R^2 = 0.320$; $F_{(6, 134)} = 10.519$, $p < 0.001$**					
Relative total effects of X on Y	***Effect***	**SE**	***t***	***p***	**LLCI**	**ULCI**
X1 (desktop PC vs. otherwise)	0.471	0.23	2.027	0.045	0.012	0.929
X2 (VR vs. otherwise)	0.871	0.25	3.519	0.001	0.381	1.359
Omnibus test of total effect of X on Y	**R^2 change = 0.179; $F_{(2, 134)} = 17.711$, $p < 0.001$**					
Relative indirect effects of X on Y	***Effect***	**BootSE**	**BootLLCI**		**BootULCI**	
T. Embodiment → Emotional reactions → Behavioral engagement						
X1 (desktop PC vs. otherwise)	-0.100	0.13	-0.340		0.183	
X2 (VR vs. otherwise)	-0.101	0.14	-0.369		0.199	
Bootstrap results for indirect effects	***Effect***	**BootSE**	**BootLLCI**		**BootULCI**	
T. Embodiment → Psychological engagement → Behavioral engagement						
X1 (desktop PC vs. otherwise)	0.117	0.09	-0.068		0.319	
X2 (VR vs. otherwise)	0.359	0.16	0.096		0.704	
T. Embodiment → Emotional reactions → Psychological engagement → Behavioral engagement						
X1 (desktop PC vs. otherwise)	0.339	0.11	0.143		0.587	
X2 (VR vs. otherwise)	0.343	0.13	0.130		0.643	

Note: n = 141. Confidence interval calculated at 95% of significance. Bootstrap sample size = 5,000. BootLLCI: lower limit confidence interval; BootULCI: upper limit confidence interval.