When art meets tech: The role of augmented reality in enhancing museum experiences and purchase intentions

Zeya He*, Laurie Wu, Xiang (Robert) Li
Temple University, 1810 N 13th St, Philadelphia, PA 19122, USA

HIGHLIGHTS

- This study examines the effects of AR technology’s design elements on visitors’ museum experiences and purchasing intentions.
- Information type and environmental augmentation were found to jointly influence visitors’ willingness to pay a higher price.
- Imagery vividness and experiential value were verified as theoretical processes that explain the effects.

ABSTRACT

As augmented reality (AR) has been increasingly adopted by various industries as a marketing tool, tourism practitioners have come to recognize its promising potential in staging experiences. Despite the extensive discussions around AR's managerial implications, academic inquiry into how to adopt AR technology in museum tourism contexts remains rare. Building on this emerging stream of scholarly literature, the current study attempts to examine the impact of information type (dynamic verbal vs. dynamic visual cues) and augmenting immersive scenes (high vs. low virtual presence) on visitors’ evaluation of the AR-facilitated museum experience and their subsequent purchase intentions. Using an experimental approach, the results demonstrate that compared with dynamic visual cues, dynamic verbal cues lead to visitors’ higher levels of willingness to pay more and such effect is more salient when environmental augmentation provides a high level of virtual presence. Such effects can be explained by the psychological mechanism of mental imagery.

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The eyes see only what the mind is prepared to comprehend.

— Robertson Davies

1. Introduction

Augmented reality (AR) technology is one of the most revolutionary inventions in recent years. Crowned the most frequently searched term on Google in 2016, “Pokémon Go” successfully introduced AR to a mass audience (Wingfield & Isaac, 2016). By augmenting a display of real-world objects and spaces with virtual information (Milgram & Kishino, 1994) to seamlessly integrate virtuality and reality (Tussyadiah, Jung, & tom Dieck, 2017), AR shows great potential as a design tool to craft innovative customer experiences across industries. AR’s popularity is expected to continue with the market estimated to reach $117.4 billion by 2022 at a compound annual growth rate of 75.72% (Forbes Agency Council, 2017).

At the forefront of staging experiences in the experience economy (Pine & Gilmore, 1999), the tourism industry has seized the opportunity to use AR technology to develop never-before-seen tourism experiences. For instance, outdoor applications such as ViewRanger and AR Mountains Map have introduced augmented trail information as tourists navigate and tag their adventures (Gooding, 2016). Indoor attractions have begun to enhance visitors’ experiences with AR, such as the new “Terracotta Warriors of the First Emperor” exhibition at the Franklin Institute in Philadelphia, which digitally showcases warriors and their weapons (Hurdle, 2017). Research on AR in tourism and travel has been spurred by these emerging trends. Extant body of tourism and travel literature has focused mainly on the prospects and challenges of AR adoption (Kounavis, Kasimati, & Zamani, 2012), potential usage scenarios (tom Dieck, Jung, & Han, 2016; Scarles, Casey, & Treharne, 2016, p. 1177;
Hassan & Ramkissoon, 2016; Chung, Han, & Joun, 2015), user readiness and acceptance of AR (Chung et al., 2015; Jung, Chung, & Leue, 2015), unique user experiences with AR (Tussyadiah et al., 2017), and consumers’ attitudes and behavioral intentions around AR adoption (Chung, Lee, Kim, & Koo, 2017). While experience design researchers argue that well-designed experiences may increase customers’ willingness to pay (Pine & Gilmore, 1999), the relationship between AR design elements and customers’ paying behavior warrants further investigation. Yet, to the best of the authors’ knowledge, no prior research has looked at the impact of AR design elements on the tourism experience and subsequent behaviors.

The current study seeks to fill this gap in the literature via mental imagery theory (Thomas, 1999) and attentional control theory (Kim & Cave, 1999). Specifically, this research examines how and why two AR design elements, information type (i.e., dynamic verbal vs. dynamic visual cues) and level of virtual presence (i.e., high vs. low), influence visitors’ museum experiences and subsequent behavioral intentions, particularly their willingness to pay more (WTPMore). As an important product that museum tourism belongs to, cultural tourism has been recognized as “one of the most important forms of tourist traffic” and is estimated to become one of UNWTO’s main focus by 2020 (Niemczyk, 2013, p. 24). In addition, cultural institutions, particularly museums, are acknowledged to be premier attractions of tourism destinations that tourists tended to visit regardless of destinations (McKercher, 2004). Therefore, this study examines how AR can enhance the tourism experience and, subsequently, the economic environment and signifies declines in government support. Museums are facing server financial challenges and are eager to convince visitors to pay more for distinct experiences in order to alleviate budgetary pressure and generate revenues (IBISWorld, 2017). Moreover, AR innovation represents a new method for enhancing visitor experiences in the museum industry despite concerns over its return on investment (Center for the Future of Museums, 2016). To that end, the current research aims to explore how AR may help museums overcome budgetary pressure by increasing visitors’ willingness to pay. The results of this study will provide meaningful and specific insights for practitioners regarding how to design AR applications to enhance the tourism experience and improve their financial prospects.

The remainder of this article is organized as follows. The theoretical background provides a literature review of the key constructs related to AR-mediated museum experience, including experiential value, AR design elements, and visitors’ willingness to pay more. The hypotheses development section introduces mental imagery theory and attentional control theory, which underpin our hypotheses regarding the effects of key AR design elements on visitors’ willingness to pay more; this section also outlines the potential mechanism that explains these effects. Following that, the methodology section details the research design and procedure. The results section presents the data description and major findings, and the article concludes with a discussion and study limitations.

2. Theoretical background

2.1. The museum tourism experience and experiential value

Museums, especially art museums, have been widely recognized as a major tourist attraction for domestic and international visitors in many destinations. Art museums are at the helm of staging experiences in today’s experiential economy. As museums face serious financial challenges (Pogrebin, 2017), they are turning their focus on enhancing the visitor experience in order to increase admission rates (IBISWorld, 2017; Kelly, 2004). Driven by service co-creation logic (Prablad & Ramaswamy, 2004), the service experience literature indicates that both the visitor and managerial perspectives should be considered in order to successfully manage visitors’ experiences (Johnston & Kong, 2011).

From a visitor’s point of view, a key construct that captures the success or failure of the entire museum experience is perceived experiential value (Chan, 2009). Perceived experiential value is based on the transaction or co-creation of experience between the service provider (i.e., museum) and the customer (i.e., visitor), particularly interactions involving direct either usage or distant appreciation of goods or services (Wu & Liang, 2009). In the context of museum tourism, previous research has suggested that the generation of visitors’ experiential value is tied to their aesthetic appreciation process (Chung et al., 2017; Csikszentmihalyi & Robinson, 1990). An aesthetic response to the museum experience contains two dimensions: 1) direct visual appeal of the museum exhibition’s design; and 2) spectacular aspects of the experience (i.e., perceptions of entertainment and amusement) (Mathwick, Malhotra, & Rigdon, 2001). As visitors transform from spectators to participants, their distant appreciation of aesthetic elements shifts to value generation (Deighton & Grayson, 1995), specifically intrinsic value. Enjoyment, as one of the core intrinsic values in this context (Beardsley, 1965; Chung et al., 2017), results from participation in absorbing immersive activities or processes that offer a sense of escape from everyday monotony (Mathwick et al., 2001; Unger & Kern, 1983). Based on these conceptualizations, experiential value in a museum context contains several key aspects: visual appeal, entertainment, enjoyment, and escapism (Mathwick et al., 2001; Shih, 2015).

From a managerial viewpoint, the management of the museum tourism experience relies on delivering inputs (i.e., the core product and the physical environment in which the product is embedded) (Falk, Koran, Dierking, & Dreeblow, 1985) by stimulating attention, interest, and engagement (Goulding, 2000). One of the two key orientations to look at the management of museum experience are the notions of “exhibit” and “setting” (Falk et al., 1985). The former maintains that the nature of an exhibit is the dominant driver behind the museum experience. The latter is more holistic; it regards the museum as a social and physical setting where individuals are constrained by social norms or physical spaces to react in a predictable way (i.e., aesthetic appreciation). Therefore, in addition to various exhibits and displays, visitors’ responses can be shaped by social and physical settings. Based on previous understanding from both perspectives, it is thus essential for museums to generate compelling stimuli through myriad exhibits and settings to successfully engage tourists in the co-creation of aesthetic experiences. Given this managerial need, the design and implementation of AR technology in museum contexts should attend to both exhibit and setting.

2.2. Augmented reality (AR) technology

As the midpoint of the reality-virtuality continuum, AR can be defined as the technique that “augmenting natural feedback to the operator with simulated cues” (Milgram, Takemura, Utsumi, & Kishino, 1994, p. 283). With the unique ability to superimpose virtual information onto physical objects and environments (Chung et al., 2015), AR can either bring real-world objects into a virtual environment or bring virtual objects into reality (Milgram & Kishino, 1994). It also has the potential to reshape the design of museum exhibits and environments and to influence users’ attention allocation (Yeh & Wickens, 2006); thus, AR can be utilized as an auxiliary tool in the management of tourists’ museum experiences. Previous studies on AR in the tourism context have investigated the challenges and prospects of AR adoption for tourism needs (Kounavis et al., 2012). Other studies have explored tourists’ readiness and acceptance of AR technology (Chung et al., 2015),
users’ and non-users’ learning performance (Chang et al., 2014), museum and other potential usage scenarios, including cultural and heritage tourism (tom Dieck et al., 2016; Scarles et al., 2016, p. 1177; Hassan & Ramkissoon, 2016; Chung et al., 2015). Most recently, the discussion has shifted to attitude and behavioral intention about AR adoption (Chung et al., 2017; Jung et al., 2015) and the unique user experience (e.g., embodiment) of AR technology in the situated tourism context (Tussyadiah et al., 2017). It can be concluded from previous studies that adopting AR in the tourism context can enhance consumers’ experiences, improve their attitudes, and increase positive behavioral intention. Moving beyond a discussion of whether and where to adopt AR, the current research examines the specific research question of how best to utilize AR design to enhance tourism experiences and improve museums’ bottom line. To the best of the authors’ knowledge, little research has explored the effects of AR design elements on tourists’ experiences and subsequent behaviors.

To fill this gap in the literature, the current research examines the impact of AR design elements on the museum tourism experience. The existing literature on museum experience management have identified two key prototypical design elements used to design AR displays in a museum context: augmenting digital assets about the exhibits and augmenting immersive scenes (Feiner, MacIntyre, Hollerer, & Webster, 1997; Wojciechowski, Walczak, White, & Cellary, 2004). Augmenting digital assets about exhibits often includes verbal descriptions of exhibits, 2D or 3D visual images, or visual animations that convey an exhibit’s transformation (Yuen, Yaoyneong, & Johnson, 2011), such as the display restored cultural relics. Augmenting immersive scenes, such as a historical, natural, or cultural virtual environment that reflects the contents of the exhibits (Wojciechowski et al., 2004), affords tourists a new level of virtual presence (Baños et al., 2004; Tussyadiah, Wang, Jung, & tom Dieck, 2018). Augmenting digital assets about exhibits and augmenting immersive scenes are integral to AR display design in a variety of scenarios (Cheng & Tsai, 2013; Yuen et al., 2011).

Given current AR design and the museum experience management literature, it can be concluded that an examination of the effects of AR design elements, especially the effects of augmenting digital assets about exhibits and augmenting immersive scenes on tourists’ museum experiences, would provide valuable insight. In particular, such research should help museum managers understand the impact of AR design elements on visitors’ experiential value and subsequent behavioral intentions, namely willingness to pay more.

3. Hypotheses development

A review of relevant literature suggests that although AR has the potential to enhance tourists’ museum experiences and visit intentions (Chung et al., 2015), specific research on the effects of AR design elements on the tourism experience and purchasing behaviors is still lacking. Taking a unique focus, this study adopts attentional control theory and mental imagery theory to examine how two AR design elements, augmenting digital assets about the exhibits and augmenting immersive scenes, may contribute to a mental imagery process in aesthetic/art appreciation.

3.1. Willingness to pay more (WTPmore)

Willingness to pay more can be defined as tourists’ willingness to pay a higher price for an event, service or experience (Baker & Crompton, 2000) compared to the normal price or that of a competitor. As a construct that directly reflects a business’ competitive advantage in the marketplace, the willingness to pay more (WTPmore) has been examined as an important behavioral construct in tourism and hospitality research (Baker & Crompton, 2000; Enrique Bigne et al., 2008). Furthermore, as many museums face significant financial challenges these days (Pogrebin, 2017), the construct of willingness to pay more also provides specific and relevant managerial implications for museum pricing policies.

Previous research has found that, in the context of leisure and tourism services, a better consumer experience can increase consumers’ willingness to pay or, alternatively, the price premium they are willing to pay (Enrique Bigne et al., 2008). Yet few studies have examined visitors’ willingness to pay more for aesthetic experiences. In particular, research has revealed very little about the driving forces behind consumers’ willingness to pay more in the context of art museum tourism. As “pay what you wish” programs become common practice in the museum industry, understanding visitors’ willingness to pay more for museum experiences will provide meaningful insights for museum tourism operations and revenue management. Adopting the measurement of WTPmore developed by Baker and Crompton (2000), the current research attempts to bridge this gap in the literature by examining the impact of AR design elements on visitors’ willingness to pay more for an art museum experience.

3.2. Aesthetic appreciation: a top-down attentional control process of mental imagery

Mental imagery is one of the primary methods individuals use to appreciate art. The mental imagery process can be defined as a nonverbal, quasi-perceptual inner representation of perceptual information in memory (Thomas, 1999). The mental imagery process is sometimes colloquially termed “visualizing” or “seeing in the mind’s eye” (Childers, Houston, & Heckler, 1985; Thomas, 1999). Mental imagery offers a primary way for the generation of aesthetic pleasure, as the system of creating vivid imagery shares core elements with the creation of aesthetic experience (Starr, 2013). By uniting sensory input, emotional perception, and semantic data and integrating information and sensation to reframe and revalue what one feels and knows, the mental imagery process helps viewers to process an art piece and to understand the artist’s personal perspective (Starr, 2013).

Previous research in aesthetic appreciation suggests that mental imagery in art appreciation involves a top-down attentional control process (Cupchik & Gebotys, 1988; Cupchik, Winston, & Herz, 1992; Winston & Cupchik, 1992). According to attentional control theory, there are two key psychological processes that individuals use in everyday information processing: top-down and bottom-up (Kim & Cave, 1999). The top-down process is a controlled or goal-directed process wherein individuals’ thoughts or intentions direct their visual attention (Kim & Cave, 1999). In contrast, the bottom-up process is more spontaneous and driven mostly by external stimuli (Kim & Cave, 1999). A similar notion to top-down vs. bottom-up processing is captured in the dual processing theory of reasoning, judgment, and social cognition (Evans, 2008).

The aesthetic appreciation process in the art museum tourism experience involves tourists paying attention to a focal object and suppressing everyday concerns to enjoy escapism (Cupchik & Winston, 1996; Cupchik, Vartanian, Crawley, & Mikulis, 2009). As such, an enjoyable aesthetic experience may require tourists to “[intentionally] shift to overcome the automatic cuing” and to “reinvest attention in the creation of experience” (Cupchik et al., 2009, p. 85). The process of art appreciation also requires an abstract level of aesthetic appreciation and knowledge interpretation to facilitate direct visual perception (Cupchik et al., 2008). In this top-down process, individuals form their own inner representations or mental imagery of an art piece given a conceptual understanding or knowledge about the art piece (Mellet et al., 1996).
For example, when trying to appreciate the famous cubist art piece Guernica by Pablo Picasso, visitors may first attempt to consider their background knowledge about the artist and the painting. They may have learned that Picasso was a famous Cubist artist and this piece was created in the 20th century to express his outrage over the Nazi bombing of the city of Guernica in northern Spain. After absorbing this knowledge, visitors may use such information to guide their visual attention and search for piecemeal elements that reflect Guernica residents’ misery, such as distorted faces, screaming animals, and dying people. Following the goal directed process, visitors may piece together the fragmentary information and eventually form their own vivid imagery about a peaceful town suffering atrocities at the hands of the Nazis. To conclude, this top-down control is key to the construction of meaningful and coherent mental images in an aesthetic experience.

3.3. Augmenting digital assets about exhibits: the effect of AR information type

By focusing on the AR design element of augmenting digital assets, this research examines which AR information that will result in a better museum experience. The study of information type on consumer judgements and behavior can be traced back to advertising literature, where a verbal cue is defined as a textual description of a product and a visual cue refers to a pictorial demonstration of a product (Stafford, 1996). With the development of information technology, print materials have been gradually replaced by digital information representation in mass communications. Following this trend, research on information type has expanded the scope of visual and verbal cues by incorporating digital animations (Boucheix, Lowe, Putri, & Groff, 2013), such as visual graphics that involve dynamics (Boucheix & Lowe, 2010; Fischer, Lowe, & Schwan, 2008) and verbal information that highlights movements and relations with dynamic presentations (Harvey & Walker, 2014).

Comparing the relative effectiveness of verbal and visual cues, previous research has identified a visual superiority effect and a verbal superiority effect under different conditions. The visual superiority effect suggests that, compared with verbal cues, visual cues generate better recognition, memory, and attitude (Childers & Houston, 1984; Nelson, Reed, & Walling, 1976; Pieters & Wedel, 2004; Rossiter & Percy, 1980). Such an effect typically emerges in conditions where people are less motivated or capable of processing information, such as when browsing websites and being mentally preoccupied. In this context, consumers tend to adopt a bottom-up information processing strategy and put forth minimal mental effort to process readily available information (Shah & Oppenheimer, 2008). Compared with verbal cues, visual cues represent stronger sensory stimuli (Nelson et al., 1976) and are easier to store and retrieve (Roediger & Weldon, 1987). Therefore, visual cues are relatively more effective in capturing consumers’ attention in conditions where individuals adopt a bottom-up information processing approach.

Meanwhile, some scholars have identified an adverse effect of verbal superiority in purchase decisions (Kim & Lennon, 2008; Roediger & Weldon, 1987). This line of research suggests that, although comprehension of verbal cues requires more effort, verbal cues (vs. visual cues) lead to greater purchasing intentions in conditions where people are more motivated and capable of processing information (Childers & Houston, 1984). For instance, when making important decisions, consumers are naturally more engaged in information processing and decision making. In such circumstances, consumers are more inclined to take a top-down semantic processing approach and to use existing knowledge or goals to direct their comprehension (Childers & Houston, 1984). As such, verbal cues outperform visual cues in shaping consumers’ purchasing intentions in terms of highly involved and engaged information processing and decision-making tasks.

In the context of the current research on art museum tourism experiences, it is proposed that verbal (vs. visual) cues should lead to greater experiential value and willingness to pay more. This supposition is underpinned by a twofold rationale. First of all, dynamic verbal (vs. visual) cues are better suited to art museum tourists’ top-down mental imagery approach to aesthetic appreciation. As argued in the hypotheses development section, visitors typically follow a top-down mental imagery process for enhanced aesthetic appreciation (Cupchik et al., 2009). At the same time, the verbal superiority literature suggests that verbal (vs. visual) cues deliver better results when individuals adopt a top-down strategy to process information (Childers & Houston, 1984). In addition, compared with visual cues, verbal cues can more effectively elicit personally relevant and meaningful mental imagery (Escalas, 2006; Walters, Sparks, & Herington, 2007). Unlike visual cues that make imaginary scenarios readily available, with verbal cues, individuals have no choice but to mentally imagine and visualize the described scenario themselves (Walters et al., 2007). Such a process allows individuals to use personally relevant knowledge to shape their mental imagery, which is a manifestation of the top-down process approach. Therefore, in the context of museum art appreciation, verbal (vs. visual) cues should be better aligned with the top-down mental imagery process; specifically, verbal (vs. visual) cues should facilitate the mental imagery process more effectively, thereby leading to higher levels of experiential value and increased willingness to pay more.

Moreover, dynamic visual (vs. verbal) cues may actually impede the mental imagery process. Prior studies have indicated that, compared with verbal cues, dynamic visual cues are particularly effective in attracting human visual attention (Carmi & Itti, 2006). As mental imagery is both visual (Kosslyn & Thompson, 2003) and dynamic (Freyd, 1987; Krishna, Morrin, & Sayin, 2013), the information encoding process of dynamic visual cues may compete for the same mental resources used for mental imagery. As such, cues that are dynamic and visual in nature may be particularly powerful in impeding the top-down mental imagery process (Logie, Zucco, & Baddeley, 1990; Unnava, Agarwal, & Haughtved, 1996). Given this barrier, when museum visitors are exposed to artwork augmented with dynamic visual animation through AR, they may feel deprived of exploratory freedom in their own mental imagery, which may further impair their experiential value and willingness to pay more. Therefore, it is proposed that:

\[ H_1: \text{Compared with dynamic visual cues, dynamic verbal cues will enhance museum tourists' WTP more.} \]

3.4. Augmenting immersive scenes: the moderating effect of AR virtual presence

It is important to note that the mental imagery process is not always initiated successfully in aesthetic appreciation. AR virtual presence, created by augmenting immersive scenes, can effectively trigger the mental imagery process in art/aesthetic appreciation and should therefore moderate the effect of AR information type on museum tourists’ WTP more.

Virtual presence can be defined as a sense of ‘being there’ in the virtual environment or, equivalently, “presence in a virtual environment [that] involves the sense of being in the virtual place rather than in the real physical place where the person’s body is actually located” (Slater & Steed, 2000, p. 414). AR technology can easily transport its users to a virtual setting by augmenting
immersive scenes. For example, by adding highly immersive sensory input such as a 3D view of a prairie and the smell of grass, an AR display can make users feel as though they have been temporarily located in a prairie rather than their actual physical space, such as a laboratory. The varying degrees of immersion provided by AR will affect users' level of perceived virtual presence.

Previous research has found that virtual presence can effectively influence individuals' mental imagery level via contextual cuing (Blascovich et al., 2002; Chun & Jiang, 1998). Virtual presence provides relevant contextual or environmental information, such as time, location, or geographic orientation, to effectively initiate mental imagery (Byrne, Becker, & Burgess, 2007). Therefore, creating a virtual presence helps an individual successfully generate mental imagery (Byrne et al., 2007). In the context of the current research, when a visitor has a high level of virtual presence, a top-down mental imagery process is activated. In such circumstances, dynamic verbal cues (vs. dynamic visual cues) should better fit the top-down mental imagery process, yielding an improved experience (Tussyadiah et al., 2018) and greater WTPmore among museum tourists. However, when visitors are exposed to a normal environment or setting in which they perceive a low level of virtual presence, they will have a stronger connection with reality, and the top-down mental imagery process may not be activated at all. AR virtual presence is thus expected to moderate the effect of AR information type on museum tourists' WTPmore. Therefore, we propose that:

\[ H_2: \text{AR virtual presence moderates the effect of AR information type on museum tourists' WTPmore, such that when an AR display provides high virtual presence, dynamic visual cues (vs. dynamic verbal cues) will further enhance museum tourists' WTPmore.} \]

3.5. The serial mediation effect via imagery vividness and experiential value

Imagery vividness can be defined as the “clarity with which the individual experiences a mental image” (Bone & Ellen, 1992, p. 96), which is by far the most prevalently used construct to demonstrate the mental imagery process (Cartwright, Marks, & Durrett, 1978; MacInnis & Price, 1987). According to Starr (2013), vivid mental images contribute significantly to aesthetic experiences. In line with our hypotheses development, mental imagery is argued to be the key psychological mechanism underlying the effects of AR design elements on museum tourists’ experiences. We propose that, especially when an AR display provides high virtual presence by augmenting immersive scenes, dynamic verbal (vs. dynamic visual) information should better facilitate the mental imagery process and therefore bring about greater experiential value and WTPmore. Put another way, when an AR display provides high virtual presence, the constructs of imagery vividness and experiential value should work in tandem (i.e., serial mediation effect, Hayes, 2013) to explain the effect of AR information type on museum tourists’ WTPmore. When an AR display does not provide augmented immersive scenes, the virtual presence level will be low and the mental imagery process may not occur at all. In such cases, the serial mediation effect of imagery vividness and experiential value should not apply. It is therefore proposed that:

\[ H_3: \text{When an AR display provides high virtual presence, dynamic visual cues (vs. dynamic verbal cues) enhance museum tourists' WTPmore via the serial mediation effect of imagery vividness and experiential value.} \]

To conclude, based on the notion that aesthetic appreciation is a top-down mental imagery process, the dynamic verbal cues provided through AR should align with the museum context and lead to higher WTPmore compared to dynamic visual cues. This effect should be moderated by the level of virtual presence, which can activate mental imagery through contextual cueing, thereby enhancing experiential value and museum tourists’ WTPmore. The proposed model is demonstrated in Fig. 1.

4. Methodology

To test the above hypotheses, this study adopted an experimental approach. A pilot study was conducted to assess the validity of the study stimuli and refine materials. Following the pilot study, the main study was carried out to test the proposed hypotheses, namely how AR design elements influence tourists’ experiences and subsequent behavioral intentions to pay more. The minimal sample size needed has been demonstrated in Appendix B.

4.1. Sample demographics

A total of 225 valid respondents (who passed the attention check) were recruited from Amazon Mechanical Turk to participate in this study. Participants were randomly assigned to the four treatment groups. About half (49%) of participants were male. About two-thirds (67%) were 18–39 years old, 83% held an associate's degree or above, and 64% had visited a museum within the past year. Detailed sample descriptive analysis can be found in Appendix C.

4.2. Design, procedure, and materials

The experiment adopted a 2 × 2 (information type: dynamic visual vs. dynamic verbal cues; virtual presence: high vs. low) between-subjects design. Participants received the research stimuli and survey questionnaire via an online link. In the video scenarios, the participants were asked to imagine they were visiting an art museum and used an augmented reality device for painting appreciation. The video portrayed the museum experience from a first-person point of view, displaying Vincent van Gogh's painting Starry Night over the Rhone along with an AR display with various design element combinations.

In the “dynamic visual cue - high virtual presence” condition, the painting was augmented with a digital display of 2D dynamic visual cues that were designed to depict the imagery from Vincent van Gogh's perspective. Cues were shown in three stages: glimmers of distant stars on a midnight blue sky; gas lighting and stars reflected on the river; and a couple strolling on the bank who had disembarked from the sailing boat moored at the port. Meanwhile, the museum environment was augmented with a content-related virtual background of gently rippling water under the moonlight. In the “dynamic verbal cue - high virtual presence” condition, the painting was augmented with a digital dynamic display of textual descriptions that described the painting's contents with words reflecting each of the aforementioned three (visual) cue stages. At the same time, the museum environment was augmented with a content-related virtual background. In the “dynamic visual cue - low virtual presence” condition, the painting was augmented with a digital display of 2D dynamic visual cues, but the museum environment was not augmented with a virtual background. In the “dynamic verbal cue - low virtual presence” condition, the painting was augmented with textual descriptions and no virtual background. Screenshots of the video stimuli used in the four scenarios appear in Appendix A.

After being exposed to the video stimuli, participants were
asked to answer several questions about experiential value, willingness to pay more, imagery vividness, demographics, etc. The survey included a manipulation check.

4.3. Manipulation check

The level of visitors’ perceived virtual presence required a manipulation check. According to Perdue and Summers (1986), concrete observable variables (e.g., colors, prices, etc.) can be relatively simple to confirm as having been manipulated as intended. Unobservable variables involving higher-order cognition, such as perceptions, cannot be altered directly and necessitate more thorough manipulation checks. To ensure virtual presence was manipulated successfully, a three-item measurement scale was used to check if “the environment that the exhibited painting described became a place, rather than just images” (7-point Likert scale: 1 = “strongly disagree”, 7 = “strongly agree”; Slater, Usoh, & Steed, 1994) (see Table 1). Participants assigned to the high virtual presence conditions rated their perceived virtual presence ($N_{high\ presence} = 112, M_{high\ presence} = 5.48, SD_{high\ presence} = 1.03$) to be significantly higher than their counterparts assigned to the low virtual presence conditions ($N_{low\ presence} = 113, M_{low\ presence} = 4.96, SD_{low\ presence} = 1.25; t = 3.42, p < 0.01$). Based on these results, the manipulation of virtual presence was deemed successful.

4.4. Measures

Following previous research, experiential value was measured using measure-established scales developed by Mathwick et al. (2001) and Shih (2015) on a 7-point Likert scale (1 = “strongly disagree”, 7 = “strongly agree”; Cronbach’s $\alpha = 0.96$). Willingness to pay more was assessed via a 2-item, 7-point bipolar scale adapted from Baker and Crompton (2000) (1 = “not at all likely”, 7 = “extremely likely”; Cronbach’s $\alpha = 0.89$). Respondents’ imagery vividness (Cronbach’s $\alpha = 0.85$) was measured by a 3-item scale adapted from Bone and Ellen (1992). Measurement scales for the major measures are summarized in Table 1. Descriptive analysis of measurement items can be found in Appendix D.

5. Results

5.1. ANOVA results - the effects of AR design elements on WTPmore

A $2 \times 2$ (information type: verbal vs. dynamic visual cues; level of virtual presence: high vs. low) analysis of variance (ANOVA) was conducted to test $H_3$, $H_4$, and $H_5$. $H_1$ posited that compared with dynamic visual cues, verbal cues would lead to greater WTPmore. ANOVA (see Table 2 and Fig. 2) results confirmed the proposed positive main effect of information type on WTPmore ($F_{1,122} = 4.10$, $p = 0.04$, $M_{verbal} = 108$, $M_{visual} = 4.28$, $SD_{verbal} = 1.43$, $SD_{visual} = 1.17$, $M_{visual} = 3.91$, $SD_{visual} = 1.33$; Cohen’s $d = 0.27$); thus, $H_1$ was supported. The results also confirmed the interaction effect of information type and virtual presence level on WTPmore ($F_{1,122} = 5.10$, $p = 0.03$) proposed by $H_2$; that is, when an AR display provided high virtual presence, dynamic visual cues (vs. dynamic verbal cues) improved museum tourists’ WTPmore. Specifically, in the conditions with a high level of virtual presence, dynamic verbal cues (vs. dynamic visual) cues significantly increased WTPmore ($M_{verbal-high\ presence} = 4.55, SD_{verbal-high\ presence} = 1.38; N_{visual-high\ presence} = 57, M_{visual-high\ presence} = 3.77, SD_{visual-high\ presence} = 1.29; t = 3.09; p < 0.01; Cohen’s $d = 0.58$; $H_3$ was supported). In the low virtual presence conditions, dynamic verbal cues and dynamic visual cues resulted in similar levels of WTPmore ($M_{verbal-low\ presence} = 3.99, SD_{verbal-low\ presence} = 1.44, M_{visual-low\ presence} = 53; M_{visual-low\ presence} = 4.03, SD_{visual-low\ presence} = 1.37, N_{visual-low\ presence} = 60; t = 0.15; p = 0.84; Cohen’s $d = 0.03$). The residual check demonstrated in Appendix E suggest that the residuals follow normal distribution.

5.2. PROCESS results – the conditional serial mediation effect of imagery vividness and experiential value

PROCESS Model 6 of serial mediation (Hayes, 2013) was used to test $H_5$, which suggested that, depending on the level of virtual presence, the effect of information type (dynamic verbal information, coded as 0, and dynamic visual information, coded as 1) on WTPmore was driven by the serial mediation effect via imagery vividness and experiential value. To conduct this test, we split the data based on virtual presence level and tested Model 6 (serial mediation) on each of the sub-datasets. Confirming the proposed hypotheses, in the high virtual presence conditions, results showed a significant negative indirect effect via imagery vividness and experiential value ($b = −0.10; 95\%$ Boot CI: $−0.27, −0.01$). In the low virtual presence conditions, the indirect effect via imagery vividness and experiential value was non-significant ($b = 0.00; 95\%$ Boot CI: $−0.12, 0.13$); as such, $H_3$ was supported.

6. Conclusions and discussion

To fill the research gap on the effects of AR design elements on the museum tourism experience, the current study examined how two AR design elements, information type (dynamic verbal vs. dynamic visual cues) and environment augmentation (high vs. low virtual presence) influenced tourists’ museum experiences and willingness to pay more. The results indicated that compared with dynamic visual cues, dynamic verbal cues exerted a positive main effect on visitors’ willingness to pay more, presumably because verbal information that attenuates automatic response and facilitates top-down processing has a verbal superior effect on visitors’ aesthetic experience and decision making. This effect is more salient when virtual presence is high (vs. low) because 1) a virtual environment can function as a contextual cue that facilitates mental imagery; and 2) vivid imagery processing enhances aesthetic experience, thereby increasing visitors’ willingness to pay more.
6.1. Theoretical contributions

Theoretically, this research advances the present body of tourism experience literature in several ways. Firstly, it fills the gap in the literature regarding the impact of AR design on tourists’ museum experiences and subsequent behavioral intentions. Current tourism and hospitality research has explored myriad outdoor and indoor AR user scenarios (Tom Dieck et al., 2016; Scarles et al., 2016, p. 1177; Hassan & Ramkissoon, 2016; Chung et al., 2015) as well as consumers’ readiness, acceptance, attitudes, experiences, and behavioral intentions towards AR adoption (Chung et al., 2017, 2015; Jung et al., 2015; Tussyadiah et al., 2017) in some scenarios. Previous studies have found that the positive effect of AR adoption improves consumers’ experiences, attitudes, and behavioral intentions in many cases; however, it appears few studies have examined how to improve the tourism experience and consumers’ behavior through AR design. This research delves into the design elements of an AR display specific to the museum tourism context to examine its effect on visitors’ experiences and willingness to pay more.

Secondly, through attentional control theory and mental imagery theory, this study demonstrated that imagery vividness is the underlying psychological mechanism that can explain the effects of design elements on visitors’ museum experiences and behavioral intentions (Kim, Kim, & Bolls, 2014; Lee, Gretzel, & Law, 2010). Previous research on AR in travel and tourism has adopted traditional theories and models of attitudes, behavior, and technology to test users’ attitudes and intentions toward adoption, overall experiences, and behavioral intentions. These include but are not limited to balance theory, reasoned action theory (Chung et al., 2017), technology embodiment (Tussyadiah et al., 2017), and the technology readiness and acceptance model (Chung et al., 2015). Previous research on AR in travel and tourism has adopted traditional theories and models of attitudes, behavior, and technology to test users’ attitudes and intentions toward adoption, overall experiences, and behavioral intentions. These include but are not limited to balance theory, reasoned action theory (Chung et al., 2017), technology embodiment (Tussyadiah et al., 2017), and the technology readiness and acceptance model (Chung et al., 2015). The current study offers a new way to examine visitors’ experiences and behavioral intentions through mental imagery theory. This perspective has been successfully utilized to explain the effect of tourism information on consumers’ experiences, attitudes, and behavioral intentions in traditional and technology-mediated virtual contexts (Goossens, 2000; Lee et al., 2010). The demonstrated mediating effect of mental imagery can potentially offer significant insight into the design and management of virtual and real-world integrated tourism information.
Having focused on static design elements, previous research in tourism and hospitality found visual cues (e.g., pictures) to play an integral role in consumption experiences (Hou, Yang, & Sun, 2017; Ye & Tussyadiah, 2011). Extending this line of research to dynamic AR design elements and museum tourism, this study provides a rationale for why dynamic verbal cues are more effective than dynamic visual cues in enhancing the aesthetic tourism experience and museum tourists’ willingness to pay more. Given such findings, the current research supplements the traditional visual superiority perspective with new insights on the adoption of dynamic design elements in AR development in tourism experiences.

Moreover, this study’s findings also demonstrate the moderating effect of virtual presence on the effect of focal AR design cues on individual consumers’ tourism experiences and willingness to pay. Previous research on destination website marketing has found it critically important to provide tourists with a sense of virtual presence in marketing stimuli designs (Lee et al., 2010). Current research has consistently revealed that virtual presence also plays a key role in the delivery of AR-facilitated experiences. Augmented immersive scenes, as one of the key digital assets specific to AR and other mixed-reality technologies (Feiner et al., 1997; Wojciechowski et al., 2004), function as a contextual cue to provide visitors a high level of virtual presence. When visitors perceive the environment that an art piece conveys to be more realistic (i.e., high virtual presence), the subsequent imagery process proceeds smoothly with the help of AR, leading to a better experience and increased willingness to pay more. However, when visitors are less able to immerse themselves into the environment (i.e., low virtual presence), the mental imagery process may not be successful, leading to an inferior experience and decreased willingness to pay more.

6.2. Managerial implications

This research reveals important implications for technology adoption and experience design for tourism and hospitality practitioners. With many tourism attractions, including museums, facing substantial financial challenges (Pogrebin, 2017), practitioners are developing new experiential programs such as special exhibitions with higher admission fees (Frey & Meier, 2006; Russeth, 2017) and discriminatory pricing for different tourist segments (Sharifi-Tehrani, Verbic, & Chung, 2013) to increase admission prices. AR, as an innovative technology, has begun to create unique experiences in many tourism settings such as museums/exhibitions (Kite-Powell, 2006) and outdoor adventures (Gooding, 2016). For instance, applications in the arts and exhibitions such as ARART offer new avenues of artistic expression by superimposing virtual animations onto famous paintings and breathing life into them (Caula, 2012). Our findings show that, with the right type of design, AR technology can potentially drive more museum revenue by providing visitors a more engaging visit. To that end, this study’s results may serve to alleviate some practitioners’ concerns about the cost effectiveness of AR in tourism settings (Kain, 2016).

More importantly, our research provides specific insights for AR adoption and display design in tourism experiences. One of AR’s most powerful features is its augmentation ability; therefore, museum practitioners may attempt to use AR to bring portraits alive. For example, the National Museum of Singapore encourages visitors to use the museum’s AR application on their cellphones to learn more about the plants or animals captured in the William Farquhar Collection of Natural History Drawings (Billock, 2017). Our findings suggest that augmenting immersive scenes can effectively enhance visitors’ perceived virtual presence and facilitate mental imagery processing. Practitioners should pay special attention to utilizing this unique AR digital asset to design a small set of virtual features that are compatible with many products (e.g., Snapchat filters: Benner, 2017) to enhance visitors’ experiences in a more cost-effective way.

Although many cases of visual animation design in AR seem eye-catching, our research findings suggest they may not necessarily result in a better visitor experience. Dynamic visual animation could potentially impede visitors’ own mental imagery in the art appreciation experience. After all, aesthetic appreciation is a highly personal experience requiring individuals’ self-driven comprehension and mental imagery. As some of the participants in the dynamic visual treatment groups pointed out that “if you tempt people to view artworks like this you are sabotaging the artist’s vision”, viewing an art piece that is augmented with visual animation could compromise the viewer’s freedom to explore his/her own mental imagery, which might impair aesthetic pleasure and experiential value. Apart from the museum tourism experience, many tourism experiences also evoke aesthetic appreciation, such as those involving food (Hegarty & O’Malley, 2001; Long, 2004), culture (Kirschblatt-Gimblett, 1998), and events (Wang, 1999). Thus, the implications of our findings may go beyond the scope of museum experience management to prove relevant in a wider array of tourism and experiential settings.

With the rapid development of information technology, people receive a wealth of alluring information through multiple channels every day. The enduring enjoyment that comes from investing attention and creating meaningfulness can be easily distracted by brief moments of sensory pleasure. Though innovative technologies like AR can use a digital display to render images more concrete and realistic, which could be compelling, the results of this study remind practitioners to be very careful when introducing these technologies for tourism marketing and management of tourism experience, especially in contexts involving aesthetic appreciation (e.g., culture tourism). The implementation of new technologies should not only be accompanied by guidance, such as contextual cues to transport tourists into the appropriate environment for optimal information comprehension, but should also allow space for better aesthetic appreciation; that is, tourists should still be able to use their imaginations to discover the “true” beauty and pleasure in artwork on their own.

7. Limitations and future research

Some limitations in this study warrant attention. First of all, this research focused exclusively on the controlled mental imagery route of processing to examine the impact of AR design elements. Other aesthetic appreciation strategies adopted by visitors, such as affect-based hedonic enjoyment and cognitive-focused learning, were not investigated. Accordingly, future studies may wish to examine how AR influences visitors’ pure hedonic enjoyment, knowledge absorption, and memory retrieval. Second, this study examined respondents’ immediate experiences and behavioral intentions towards AR without exploring long-term impacts. While AR can boost visitors’ experiences and willingness to pay when such technologies are initially adopted, it is not warranted that these effects are sustainable. In the future, a longitudinal study could provide a better understanding of the impact of AR adoption and design on visitor loyalty and relational engagement with a museum. Furthermore, the current study assessed the impact of AR design on a generic group of visitors without considering by-segment difference. Previous studies have suggested that, in the context of art appreciation, novice and experienced viewers could potentially employ different evaluation and judgment processes (Winston & Cupchik, 1992). Subsequent research could extend the current study by exploring whether AR design generates different impact on novice vs. experienced viewers. In addition, it was noted that young and well-educated individuals, a group who likely have
different preferences and intentions from other segments, were overrepresented in the study participants. While sample of such nature provides unique insights for museum practitioners regarding how to attract the millennial consumers, notably one of the most important visitors segment (Patel, 2017), it may also limit the generalizability of this research. Further research could be conducted to test if findings of this research are generalizable across generations and educational levels.

To conclude, this study explored the impact of AR design elements on visitors’ tourism experiences and willingness to pay more through a top-down mental imagery process in a museum setting. More research is welcomed to see if such effects can be explained by other mechanisms or generalized across time, contexts, and populations. It is our hope that this research will shed light on the topic of technology and aesthetic tourism in addition to encouraging continued empirical investigation to advance theories and practices that can explicate tourists’ experiences and behavior.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.tourman.2018.03.003.

Appendix A. Screenshots of experiment stimuli

![Video scenario describing a museum experience with high virtual presence × dynamic visual information](image1)

![Video scenario describing a museum experience with low virtual presence × dynamic visual information](image2)

![Video scenario describing a museum experience with high virtual presence × dynamic verbal information](image3)

![Video scenario describing a museum experience with low virtual presence × dynamic verbal information](image4)
Appendix B. Test of sample size adequacy

<table>
<thead>
<tr>
<th>Anticipated effect size</th>
<th>Desired statistical power (Cohen’s $f$)</th>
<th>Number of predictors</th>
<th>Significance level</th>
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Appendix C. Sample frequency and descriptive analysis

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Appendix D. Descriptive analysis of measurement items

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Appendix E. Normality test of residuals

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</table>
Normal Q-Q Plot of Residual for WTPmore

Normal Q-Q Plot of Standardized Residual for WTPmore

References


Zeya He is a Ph.D. student in the School of Tourism and Hospitality Management at Temple University. Her major research interests lie in service technology and travel behaviors.

Laurie Wu, Ph.D., is an Assistant Professor in the School of Tourism and Hospitality Management at Temple University. Her major research interests include consumer behavior and service marketing in tourism and hospitality.

Xiang (Robert) Li, Ph.D., is a Professor and Washburn Senior Research Fellow at the Department of Tourism and Hospitality Management, Temple University. He is also Director of Temple’s U.S.-Asia Center for Tourism and Hospitality Research. Robert’s research mainly focuses on destination marketing and tourist behavior, with special emphasis on international destination branding, customer loyalty, and tourism in Asia. Robert’s research findings have appeared in numerous top-tier tourism, business, leisure, and hospitality journals.