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Memories of tourism brands in virtual reality

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ABSTRACT

In three studies (a lab experiment, a field experiment, and a qualitative study), this research investigates memories formed by tourism brand experiences in virtual reality. Specifically, this work establishes to what extent episodic and semantic memories from virtual reality tourism brand experiences are formed and retained, and what mechanisms underscore this process. Moreover, using a bespoke virtual environment and adopting a longitudinal approach, this research demonstrates how accuracy and confidence in episodic and semantic memories of a tourism brand formed in virtual reality evolve over time. We discuss how virtual reality tourism brand experience can spur memory pre-, during and post-tourist visit. Theoretical and managerial implications are considered.

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Introduction

Creating memories has long been considered the "raison d'être" of tourism (Pizam, 2010, p. 343), and a substantial focus of tourism research (Sterchele, 2020; Tung & Ritchie, 2011; Unger & Uriely, 2022; Wood, 2020). Currently, technology such as virtual reality, an immersive technology that 'transports' users to a different place and time (Berg & Vance, 2017; Kostyk & Sheng, 2023), is transforming tourism experiences. For instance, The Met developed an application that 'takes' tourists on a tour of their special exhibitions (The Met, 2020). Resulting consumer memories hold considerable promise for tourism brands. Yet we know little of virtual reality's impact on memory. It is more involving than other media, which can increase memorability (Campos et al., 2017; Cowan & Ketron, 2019; Jiang et al., 2023; Litvak & Kuflik, 2020). Additionally, studies suggest that memories formed in virtual reality transfer to the real world (Smith, 2019), and might influence tourists' intentions and behaviors toward tourism brands. Indeed, a recent study found that 62 % of consumers would use this technology for travel decision-making (VR for Tourism, 2023). Incorporating virtual reality into different stages of the tourist journey can create memories that impact tourist choices during planning, as well as refresh memories of real-life experiences post-visit (Aldossary & McLean, 2022; Tung & Ritchie, 2011).

Currently, tourists' memories formed in virtual reality are not well understood. First, we do not know if these experiences (e.g., sample visits) create memories similar to real-life visits or if they form memories akin to advertisements. Generally, individuals process real-life experiences more deeply, so these experiences are less prone to heuristic biases and their persuasive effects are more permanent (Lange et al., 2016). However, we do not know how virtual experiences influence memory formation and retention, an important aspect of tourism satisfaction (Zare & Pearce, 2022). Research is unclear whether virtual reality helps or harms memory

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formation. While it blocks distractions, facilitating information-processing (Optale et al., 2010), it also triggers cognitive overload (Mayer & Moreno, 2003). Second, we do not yet understand how tourists' memories formed in virtual reality evolve, as extant research typically adopts a cross-sectional approach (for an exception, see Sterchele, 2020). Given that tourism decision-making processes can span over weeks or months, and be delayed or reconsidered, long-term tourist memories are of particular interest (Karl et al., 2021; Wong & Yeh, 2009).

This lack of understanding is further complicated by the existence of multiple memory systems. Psychology research distinguishes between semantic (i.e., a mental "thesaurus" of facts) and episodic (i.e., autobiographical events) memories. Previously visited and yet-to-be-visited tourism sites evoke both memory systems, informed by prior experiences as well as external sources (Cardoso et al., 2019). These memories differentially affect tourists' decision-making (e.g., Herz & Brunk, 2017; Schacter et al., 2015). It is therefore important to understand what types of memories can be formed through different interactions. Research in neuroscience and education provides limited and conflicting insights (Mayer & Moreno, 2003; Smith, 2019). Moreover, both memory types tend to be imprecise as time passes (Koenig-Lewis & Palmer, 2008; Montgomery & Unnava, 2009). Existing studies do not provide a conclusive answer as to whether memories formed in virtual reality tend to be accurate, particularly in comparison to real-life experiences (cf.: Johnson & Adamo-Villani, 2010; Kim et al., 2012; Mania & Chalmers, 2001). This has important implications for tourism brands, as inaccurate memories can impact tourists' beliefs and behaviors. While tourists' confidence in the accuracy of their memories also impacts their decision-making, little is known about the ability of virtual reality experiences to instill confidence (Baumgartner et al., 1992; Schacter et al., 2015). Lastly, studies of memory in psychology, neuroscience, and other fields involve remembering simple tasks (e.g., word lists) rather than complex, multifaceted experiences in actual tourism environment (Baumgartner et al., 1992; LaTour & Carbone, 2014). Therefore, prior findings on memory might not generalize to the tourism settings, and further investigations of tourists' memories are warranted.

While virtual reality has potential to provide enduring memories compared to other media and can complement on-site experiences, research has yet to investigate this potential. Bridging these gaps, the current work aims to address the following questions: 1) To what extent are (a) episodic and (b) semantic memories from tourism brand experiences in virtual reality formed and retained? (2) How accurate are (a) episodic and (b) semantic memories formed from tourism brand experiences in virtual reality? (3) What are consumers' confidence levels in (a) episodic and (b) semantic memories formed from tourism brand experiences in virtual reality? (4) What mechanisms underscore (a) episodic and (b) semantic memories from tourism brand experiences in virtual reality?

We investigate these research questions via a multi-method approach: (1) a longitudinal lab experiment, (2) a longitudinal field experiment, and (3) an exploratory qualitative study. Our findings provide four contributions. First, the results contribute to memory literature by documenting how virtual reality experiences follow patterns akin to real-life experiences, yet accuracy of these memories is higher than that of real-life experiences. Second, we identify several mechanisms underlying memory formation in virtual reality. Aside from the technology features (realism, interactivity, immersivity, telepresence), this technology increases individuals' confidence in memories. Moreover, these memories can be impacted by past experiences and tourism brand attachment. Third, we demonstrate how tourism brand experiences in virtual reality can spur memory recall pre-, during and post-travel. Pre- and during travel, they heighten semantic associations, while post-travel, they represent a wow-moment to strengthen and reinforce memory. Finally, we offer managerial implications by explaining how tourism brands can use this technology to encourage visits (pre-visit) and reinforce positive memories (post-visit), which could trigger re-visits, WOM, and more.

Theoretical background

Memory of tourism brand experiences

Brands are important in tourism due to their experiential nature (Clarke, 2000). Here, 'tourism brands' refer to a broad range of brands within the tourism sector, including destination brands, services, experiences, and products related to tourism, such as tour operator brands, transport and airlines, hotel and hospitality brands, tourist attractions, historic sites, and more (Clarke, 2000; Gnoth, 2002; Pike, 2005; So et al., 2014; UN Tourism, 2024). Consumers interact with tourism brands through various channels, such as in person or via traditional or digital media (Hoch, 2002; Ofir & Simonson, 2007). Memories of these interactions play a critical role in decision-making, as tourists rely on internal (i.e., memory) and external sources to inform their beliefs and behaviors (Kerstetter & Cho, 2004; Moutinho, 1987). Moreover, external sources are impacted by others' memories via word-of-mouth (Tung & Ritchie, 2011).

Memories of tourists' experiences drive various outcomes for tourism brands. Specifically, they influence satisfaction, tourism brand image perceptions, ability to plan for a visit, and (re)visit intentions (Kerstetter & Cho, 2004; Kumar & Kaushik, 2018; Unger & Uriely, 2022; Wood, 2020). Memorable tourism experiences that provide rich and vivid details have a lasting impact on individuals (Tung & Ritchie, 2011; Wright, 2010), leading to reminiscence and reflection (Kim, 2018).

Investigating memories resulting from tourism brand experiences requires distinguishing between memory types: semantic and episodic. Semantic memory acts as a "mental thesaurus" of symbols and concepts, reflecting "knowledge" rather than mere "remembering". Semantic brand memories encompass known facts about brand characteristics, attributes, elements (e.g., brand name or logo), heritage, and other associations (e.g., product category, benefits; Herz & Brunk, 2017; Warlop et al., 2005). For some brands, semantic memories are paramount, especially where prior interactions are scarce or inaccessible. Non-consumers hold more semantic than episodic memories of a brand (Herz & Brunk, 2017) and attribute more abstract than concrete associations to it (Cardoso et al., 2019). Semantic knowledge is contrasted with "experience knowledge", suggesting that it is somewhat independent of a specific brand interaction (Ofir et al., 2008; Park et al., 1994). Brand attitudes, a form of semantic brand memory (cf.: Johnson et al., 2011; Ochsner & Lieberman, 2001), can be constructed without direct experiences (Cohen & Reed II, 2006).

Sensory marketing literature distinguishes between "conceptual knowledge" (factual information) and "perceptual knowledge" (sensory cues experienced by an individual; LaTour & LaTour, 2010). Episodic memory stores "autobiographical" events and their temporal-spatial relationships (e.g., specific brand interaction), representing a person's experience (Conway & Pleydell-Pearce, 2000; Tulving, 1972). Episodic memories of brands include personal events such as visiting brand locations or viewing brand advertising (Baumgartner et al., 1992; Herz & Brunk, 2017). During such personal events, the human brain generates mental "memory markers" to record sensory and environmental changes (Ahn et al., 2009). These are clustered into sub-experiences, some of which might be more memorable than others (Ezzyat & Davachi, 2011; Unger & Uriely, 2022).

Both memory types are important and prioritized differently in tourism marketing. Episodic memories tend to produce more polarizing views of brands (very favorable or unfavorable; Herz & Brunk, 2017). Consumers rely on episodic memories to conjure episodic future thinking - the construction of possible future scenarios. In other words, consumers base their prediction of *future* interactions on episodic memories of *prior* brand experiences (Karl et al., 2021; Schacter et al., 2015). For marketing programs focusing on addressing negative past experiences or building trust, episodic memories that can inform future thinking about the tourism brand are critical (Cardoso et al., 2019). Alternatively, as aforementioned, semantic memory formation can be helpful for establishing initial brand attitudes (Herz & Brunk, 2017).

Memory of tourism brand experiences in virtual reality

Marketers assume that brand memories influence consumers long-after the experience (Marschall, 2017). As purchase or visit decisions typically do not immediately follow a brand interaction, it is important to investigate the dynamic properties of consumer memory (Krishnan & Smith, 1998). In fact, assessing consumer memories over time can be more predictive of decision-making than immediate assessments (e.g., exit surveys common in hospitality and tourism). This is because memory can be imprecise, and cognitive biases prevent tourists from accurately assessing what they will remember (Koenig-Lewis & Palmer, 2008). Additionally, as time passes, evaluations and memories might change (Montgomery & Unnava, 2009; Wood, 2020). Misremembering has important implications for tourism brand perceptions (Braun et al., 2002; Krishnan & Smith, 1998). Even though memories might be inaccurate, consumers rely on them to inform behaviors (Marschall, 2017; Pearce & Packer, 2012). As information processing depends on the channel or environment (e.g., social media versus a real-life visit; Lange et al., 2016), understanding the specific impact of virtual reality on tourists' memories is crucial. Some studies suggest that delivering virtual brand experiences might influence resulting memory (Herz & Rahe, 2020). For tourism brands investing in costly technology, as well as researchers, understanding the memory types created and retained via virtual reality and their alignment with marketing objectives is essential. Yet, extant literature on this topic is limited.

In education, virtual reality promotes learning (i.e., semantic memory, Johnson & Adamo-Villani, 2010). In marketing, it impacts consumer attitudes toward the brand, a form of semantic memory (Alyahya & McLean, 2022; Ochsner & Lieberman, 2001). Interestingly, some authors also point out virtual reality's similarity to real-life interactions with a brand (e.g., real-life visit; Dobrowolski et al., 2014). Like real-life interactions, it requires cognitive and emotional involvement, facilitates a high degree of control, and promotes greater engagement (Daugherty et al., 2008; Spielmann & Mantonakis, 2018). It is possible that like real-life interactions, it forms autobiographic memories capturing this personal experience (i.e., episodic memories). Some neuroscience research suggests that virtual reality is indeed associated with neural activity typical for autobiographic episodic memories (Kisker et al., 2021; Lenormand & Piolino, 2022; Schone et al., 2019). However, there is a paucity of research showing how tourism brand experiences in virtual reality influence the two memory types. Hence,

RQ1. To what extent are (a) episodic and (b) semantic memories from tourism brand experiences in virtual reality formed and retained?

Accuracy of tourism brand memories

It is unclear how memory accuracy of virtual reality compares with that of real-life brand experiences. Excessive arousal, typical in virtual realm, might hinder memory (e.g., Kim et al., 2012). In a cognitively demanding virtual experience, consumers' ability to "record" information into memory structures might be diminished. Research examining the effect of different media on semantic and episodic memory recall finds evidence of more accurate recall in real-life experiences (vs. virtual reality; Mania & Chalmers, 2001). However, this study investigates education, and not the complex interactions with tourism brands. Other research suggests that virtual environments are free from external distractions (i.e., 'noise'), thus encouraging uninterrupted attention (Optale et al., 2010). Consequently, focused cognitive processing during an experience results in better memory (Ying et al., 2022).

Some researchers posit that semantic memories formed in virtual reality (vs. real-life) are less accurate (Smith, 2019). Yet, semantic recall might be enhanced as virtual reality offers more detail to remember about a brand, especially when several senses are engaged (Ahn et al., 2009; Hyun & O'Keefe, 2012; LaTour & LaTour, 2010; Rottenstreich et al., 2007; Warlop et al., 2005).

Episodic memories of virtual reality can be misremembered. Anecdotally, in an unrelated survey, the authors noticed that 32 % of respondents recalling a virtual reality experience with a specific tourism brand reported wrong details (e.g., encountering a "medieval blacksmith" where there was none; see: Bartlett, 1932). Yet, research suggests that heightened immersion and vividness of this technology typically improves retrieval of episodic memories (Johnson & Adamo-Villani, 2010; Kisker et al., 2021; Schone et al., 2019). The probability of remembering episodic memories accurately might be higher for virtual reality (vs. real-life; Mania & Chalmers, 2001).

Importantly for both memory types, virtual reality (vs. real-life) content is better recalled when more positively emotionally laden, like tourism brand experiences (Ceccato et al., 2024). Consequently,

H1. Tourism brand experiences in virtual reality (vs. real-life) result in higher (vs. lower) accuracy of (a) episodic and (b) semantic brand memories.

In addition to factual accuracy of brand memories, it is necessary to evaluate perceptions related to this accuracy (Baumgartner et al., 1992; Schacter et al., 2015). Studies show that memory accuracy and individual confidence in that accuracy are not always correlated, and change independently over time (Cowley, 2002; Krishnan & Smith, 1998). Yet, consumers use feelings of confidence in their memories as a 'proxy' for accuracy to inform decision-making (Cowley, 2002). Virtual reality's vividness and ability to eliminate informational 'noise' might aid consumer confidence in memories (Hyun & O'Keefe, 2012; Optale et al., 2010). Limited prior studies find that participants in virtual reality (vs. real-life) might feel equally or less confident in their episodic memories, and less confident in their semantic memories (Ceccato et al., 2024; Mania & Chalmers, 2001). However, we expect such experiences in tourism to promote better memories due to the positive emotions they evoke (Ceccato et al., 2024). Hence,

H2. Tourism brand experiences in virtual reality (vs. real-life) result in higher (vs. lower) confidence in accuracy of (a) episodic and (b) semantic brand memories.

Extant literature diverges in identifying underlying mechanisms that drive virtual reality memories. While prior research aims to understand how consumers process information in virtual realm (Cowan et al., 2021), research on these experiences and associated memories is rather limited (Cowan & Ketron, 2019). Kim and Biocca (1997) argue that telepresence – a sensation of 'being' in a particular environment and a hallmark of virtual reality – should drive memorability. In other words, individuals should produce more cognitive elaborations when they experience telepresence, thereby enhancing memory. Similarly, some studies suggest that this technology is associated with sensory richness and vivid imagery, which in turn might impact memorability of an experience (cf.: Braun-LaTour et al., 2006; Harz et al., 2022; Tung & Ritchie, 2011; Wright, 2010; Zheng et al., 2022). However, we lack a detailed understanding of how tourism brand experiences in virtual reality affect memory. Thus,

RQ2. What mechanisms underscore (a) episodic and (b) semantic memories from tourism brand experiences in virtual reality?

Methodology

Three studies address two RQs and two hypotheses. Studies 1 and 2 adopt an experimental approach. Study 1 examines memories created by tourism brand experiences in virtual reality over time, differentiating episodic from semantic memories. Study 2 further documents these effects, comparing virtual reality and real-life tourism brand memories, testing the hypotheses. Additionally, Study 2 provides insight into how these experiences influence tourists' memories. Finally, study 3 analyzes interviews, providing a more nuanced perspective into the relationships identified from the first two studies.

Study 1

Participants and procedure

Participants ($N = 39$, $M_{age} = 24$, $SD_{age} = 3.61$, 67 % women) were recruited for this lab experiment in a business school in Belgium. A virtual reality experience with the Liège Aquarium Museum brand was developed for this experiment using Unity3D technology. Participants interacted with various animals, such as porpoises, fin whales, and crabs in different scenes and were exposed to scientific facts about animals, similar to the real-life museum visit.

Within-subjects experimental design involved assessing variables of interest at two points in time (T1 and T2). At T1, participants used virtual reality headsets (Meta Quest 2) in a lab. Upon completing the experience, participants responded to a questionnaire. An unaided brand name recall question assessed their semantic memories. Next, participants responded to 3 semantic memory statements, designed as True/False questions related to general knowledge about the museum (e.g., "The museum allows one to discover vertebrates and invertebrates"). Episodic memories were similarly assessed via three statements, referring specifically to what happened in the virtual environment. The statements were also designed as True/False questions (e.g., "In virtual reality, underwater, I saw that the leaves of the plants were round"). Participants also answered questions for a conceptually unrelated project. For control, cybersickness was measured (1–"No discomfort/sickness at all" to 100–"A lot of discomfort/sickness"; Bouchard & Robillard, 2019). Lastly, demographics were collected. After 3 weeks (T2), participants responded to an identical questionnaire. As most tourists select their visit options within a month (Phocuswright, 2020), a delay of up to one month was deemed relevant, and feasible for execution.

Analysis and findings

Most participants did not experience cybersickness/discomfort ($M = 16.13$, $SD = 17.1$, Median = 10.00). One participant with a score above mid-point (71) was excluded from analyses. A repeated-measures ANOVA with time as the within-subject factor revealed the impact of time on episodic and semantic memories of the experience. Episodic memory accuracy at T1 ($M = 2.00$, $SD = 0.81$) was higher than at T2 ($M = 1.58$, $SD = 0.76$, $F(1,37) = 12.94$, $p = 0.001$, $\eta_p^2 = 0.26$). However, semantic memory accuracy did not differ between T1 and T2 ($p = 0.21$). As a form of semantic brand memory, brand name recall changed significantly from T1 to T2

(McNemar's $\chi^2(1) = 4.0, p = 0.039$). While 63 % of participants recalled the brand name correctly at T1, this number increased to 82 % at T2.

Discussion

The results showed significantly fewer accurate episodic memory statements at T2 versus T1. Consistent with prior research conducted with other types of tourism brand experiences, this suggests memory decay (Krishnan & Smith, 1998). Interestingly, semantic memory accuracy of virtual reality was unaffected by time. Moreover, there was an increase in brand name recall from T1 to T2. This can be attributed to 'solidification' of semantic tourism brand memories. Alternative explanations might be that participants actively sought out more information about the tourism brand over time. While this study does not contrast virtual reality with real-life experiences, it lends insight into the impact of these experiences on semantic and episodic memory (RQ1). Our next study addresses H1 and H2 by contrasting memories of virtual reality vs. real-life experiences.

Study 2

Participants and procedure

Two hundred and fifty-nine participants ($M_{age} = 33, SD_{age} = 15.5$, 58 % women) were recruited for this 2 (Experience: virtual reality vs. real-life) x 2 (Time: T1 vs. T2) mixed-design field experiment, taking place at the Liège Aquarium Museum in Belgium. About half of respondents (49 %) had visited the museum previously, and most (76 %) prior visits were more than one year ago. For the between-subjects manipulation, museum visitors were randomly invited to either partake in a regular experience (real-life museum visit) or a virtual reality experience. The study used the same virtual environment developed for Study 1. Upon completing their experience, visitors in both conditions completed a T1 questionnaire, with time representing the within-subjects condition. Respondents also answered questions for a conceptually unrelated project.

Participants' cybersickness was measured (1–A lot of discomfort/sickness to 7–No discomfort/sickness at all) for those in the virtual reality condition. Next, an open-ended question assessed participants' semantic memories, asking to describe things that came to mind when they thought of the Aquarium Museum brand. Following this, participants listed 3 words to describe the brand. Next, they were exposed to three semantic memory True/False statements, similar to Study 1. For each statement, participants indicated their degree of confidence that the answer was correct (1–no confidence to 5–certain; Mania & Chalmers, 2001). Episodic memories were first assessed via an open-ended question: "When you think of your museum experience, which elements and in which order do you recall?" Next, participants were exposed to three True/False statements to assess episodic memory accuracy. Additionally, participants indicated the degree of confidence that the answer was correct. All semantic and episodic memory assessments were tailored to the specific tourism brand experience. Six experts recruited among the Aquarium Museum management reviewed the questionnaire and confirmed equal level of difficulty between memory assessments for those in real-life vs. virtual reality experience.

A post-test ($N = 50, M_{age} = 36, SD_{age} = 13.6$, 56 % women) was conducted to compare the difficulty of memory assessments. English-speaking European participants were recruited on Prolific and shown four scenes from the museum's virtual reality or real-life experience. They were asked to respond to the True/False statements from the main study and rate question difficulty (1 – very difficult to 5 – very easy). Ten responses were removed as incomplete. Analysis of the remaining responses indicated that cumulative difficulty of questions about the real-life experience ($M_{real} = 10.29, SD_{real} = 3.47$) did not differ from questions about virtual experience ($M_{VR} = 10.04, SD_{VR} = 2.25, p = 0.786$).

In the main study, participants were contacted again after 4 weeks (T2) and responded to a questionnaire identical to T1. This is comparable with Study 1 as it represents up to one month delay relevant for tourism decision-making (Phocuswright, 2020). At T2, subjects were incentivized with an Amazon gift card. Overall, 95 respondents completed T2 (37% response rate). Eleven responses were deleted due to an experimental error (i.e., participants were accidentally asked about the wrong brand experience), leaving 84 usable responses.

Analysis and findings

Most participants did not experience cybersickness/discomfort in virtual reality ($M = 5.33, SD = 2.88$, Median = 6, higher scores represent lower cybersickness/discomfort). As before, eight participants with a score below the mid-point (<4) were excluded from analyses. Repeated-measures ANOVA with time as within-subject and experience type (virtual reality vs. real-life) as between-subjects factor evaluated the impact on episodic and semantic memories. Prior visits served as a covariate. Pairwise deletion method was employed for any missing data.

Investigating episodic memory accuracy, there was no interaction between brand experience type and time ($F(1,73) = 0.02, p = 0.89$). However, there was a main effect of the experience type, such that those in virtual reality (vs. real-life) experience had more accurate episodic memories ($M_{VR} = 2.22, SD_{VR} = 0.08$ vs. $M = 1.85, SD = 0.08, F(1,73) = 9.23, p = 0.003, \eta_p^2 = 0.11$). Prior visits were not a significant covariate ($p = 0.97$). Further, there was a main effect of time, such that at T1 (vs. T2) respondents had more accurate episodic memories ($M_{T1} = 2.04, SD_{T1} = 0.08$ vs. $M_{T2} = 2.03, SD_{T2} = 0.07, F(1,73) = 7.23, p = 0.009, \eta_p^2 = 0.09$). Prior visits were a significant covariate ($p = 0.005$).

Regarding visitors' confidence in episodic memories, there was an interaction between experience type and time ($F(1,72) = 18.28, p < 0.001, \eta_p^2 = 0.21$). Contrasts revealed that while immediately after the interaction those in the real-life experience were more confident in their episodic memories ($M = 4.25, SD = 0.63$ vs. $M_{VR} = 3.52, SD_{VR} = 1.04$), this reversed as time passed ($M_{VR} = 3.13, SD_{VR} = 0.81$ vs. $M = 2.85, SD = 1.01$). Further, there was a main effect of time, such that visitors were more confident

in their episodic memories at T1 versus T2 ($M_{T1} = 3.88, SD_{T1} = 0.10$ vs. $M_{T2} = 2.99, SD_{T2} = 0.11, F(1,72) = 6.30, p = 0.014, \eta_p^2 = 0.46$). Prior visits were not a significant covariate ($p = 0.89$).

Semantic memory accuracy was not affected by the interaction between experience type and time ($F(1,73) = 0.16, p = 0.67$). Further, there was no main effect of time ($F(1,73) = 2.90, p = 0.09$). Prior visits were not a significant covariate ($p = 0.08$). However, there was a main effect of brand experience type, such that visitors had more accurate semantic memories following virtual reality experience ($M_{VR} = 5.33, SD_{VR} = 0.11$ vs. $M = 5.00, SD = 0.11, F(1,73) = 4.53, p = 0.037, \eta_p^2 = 0.06$). Prior visits were not a significant covariate ($p = 0.41$).

Visitors' confidence in semantic memories was not affected by the interaction between brand experience type and time ($F(1,68) = 1.39, p = 0.24$). There was no main effect of time ($F(1,68) = 3.77, p = 0.056$). Prior visits were not a significant covariate ($p = 0.38$). There was no main effect of experience type on semantic memory confidence ($F(1,68) = 0.11, p = 0.75$). Prior visits were not a significant covariate ($p = 0.53$).

Open-ended responses were analyzed by a post-graduate coder. When participants were asked to describe their experience in their own words, both episodic and semantic memories were richer at T2. Overall, respondents used twice as many words and sentences at T2 and recalled more parts of the museum. Episodic memories were more vivid at T2. Respondents presented all events in autobiographical manner as sequences. Further, they referenced emotions throughout the brand experience (being "impressed" and "amazed", or "loving it"). The coder identified roughly twice as many of these aspects at T2 than at T1. Interestingly, the analysis of the "wow moment" of the experience reveals that virtual reality is recalled, especially at T2, by almost all respondents, as the highlight. This technology is thus a key moment and more 'sticky' than other memorable aspects of a tourism brand experience, over time.

Similarly, semantic elements were more numerous at T2. Respondents at T2 had more ease remembering sections of the museum, as well as animals on display. They used adjectives to describe the museum such as 'nice', 'fun', 'interesting', 'enriching', 'impressive', and sometimes referred to the sensory nature of virtual reality. Respondents were also asked to mention their "top of mind" unaided semantic associations with the museum brand. Overall, their semantic associations were positive, related to the animals, or overall instructive and fun aspects of the museum. Respondents seem to have learned, and answers at T2 tended to be longer, whilst similar in content.

Discussion

Visitors who participated in virtual reality (vs. real-life) brand experience condition had more accurate episodic and semantic memories, supporting H1a and H1b. Aligned with Study 1, results suggest that episodic memory accuracy of tourism brand experiences in virtual reality decayed over time (RQ1a), but this also occurred for the real-life experience. Thus, virtual reality experiences are seemingly superior to real-life experiences in facilitating memory formation.

This technology was also advantageous in terms of episodic memory confidence as time passed. While immediately after the experience, those who took part in a real-life visit felt more confident in their episodic memories, as time passed, those in the virtual reality experience were more confident in their episodic memories, supporting H2a. This could be because consumer confidence in memories, as well as confidence decay, might be dependent on sensory impressions (Krishnan & Smith, 1998), lending initial insight into RQ2. As virtual reality represents a sensory-rich experience (Alyahya & McLean, 2022), it might boost memory confidence. However, H2b was unsupported, as brand experience type did not impact semantic memory confidence. Rather, both experience types led to similar semantic memory confidence at T1 and T2. Interestingly, addressing RQ1 and in line with Study 1, this offers support for the 'solidification' of semantic brand memories over time, hinted by stable confidence in semantic memories as time passes (RQ1b).

Analysis of open-ended responses to address RQ1 suggests that memories of tourism brand experiences in virtual reality grow richer over time, more so for episodic memories. Yet, these findings should be taken cautiously, since it is probable that respondents devoted more time to the questionnaire at T2 than at the tourism site (T1). Still, the data shows memories to be richer over time, while similar. Notably, virtual reality stands out as an experience highlight, which solidifies as a "wow moment", even if specific details are forgotten. This is relevant as prior research suggested that it is specifically "moments of amazement" that make visitor experiences memorable and impactful (Li & Su, 2024; Morgan, 2006).

While the first two quantitative studies test H1 and H2, and provide initial insight into all RQs, they also highlight nuances in how tourism brand experiences in virtual reality are remembered. To further disentangle the effects of this technology on memory and given the lack of prior research in this area, we adopt qualitative approach next.

Study 3

In line with prior work examining the role of memory in consumer-brand experiences (Herz & Brunk, 2017), this research adopts a pragmatic approach to inquiry and seeks to complement quantitative insight with qualitative data. Using mixed methods allows addressing all research questions adequately as qualitative inquiry brings depth and nuance to quantitative findings (Creswell, 2003).

Participants and procedure

Adopting a phenomenological approach, this study aimed to analyze first-hand accounts of tourism brand experiences in virtual reality (Thompson et al., 1989). A semi-structured interview guide was developed asking participants about the sequence of events that took place along with resulting thoughts, feelings, and behaviors; interviews took an organic approach, so the questions were not discussed in strict order (Thietart, 2001). Using snowball sampling, starting from the authors' network, individuals were prequalified and invited to speak about their tourism brand experience in virtual reality via videoconference or in-person; some also answered questions for a conceptually unrelated project on the same call. Participants had access to a headset similar those

Table 1
Study 3 interviewee details.

ID	Age	Gender	Nationality (Language)	Tourism Brand(s)	Interview length	Interview medium
1	37	Male	Belgian (EN)	Japan & Thailand	20'	Zoom
2	38	Male	American (EN)	Cat Café & Whisky distillery	30'	Lifesize
3	34	Male	American (EN)	High Tea in London	20'	Zoom
4	48	Male	Belgian (FR)	Notre Dame de Paris	43'	In person
5	24	Male	Belgian (FR)	London city tour	25'	In person
6	24	Female	Belgian (FR)	Liverpool Wheel	30'	Skype
7	23	Female	Belgian (FR)	Ljubljana city tour	21'	In person
8	22	Female	Belgian (FR)	Niagara Falls	22'	In person
9	23	Female	Belgian (FR)	British Museum, London	31'	In person
10	28	Female	Swedish (EN)	Edinburgh Zoo	30'	Zoom
11	27	Male	Luxemburgish (EN)	Rome city tour	30'	In person
12	42	Male	British (EN)	Sketch restaurant in London	16'	Zoom
13	40	Male	American (EN)	Anne Frank House Amsterdam	42'	Zoom
14	40	Male	American (EN)	Ripley's Aquarium of Canada	12'	Zoom
15	22	Female	Belgian (FR)	Auschwitz & Venice Beach	46'	Teams
16	22	Female	Belgian (FR)	Eiffel Tower Paris & Anne Frank House	30'	Teams

used in Studies 1 and 2, ensuring consistency. The experiences were freely chosen by participants and unlike Studies 1 and 2 did not involve a virtual environment designed by the research team. The full sample included participants of diverse backgrounds (see Table 1). The interviews were conducted in English or French, depending on participant preference, and audio-recorded, resulting in 8 h of audio, transcribed and subjected to thematic analysis using NVivo 12 software. Open coding was carried out to identify initial themes present in the data (Corbin & Strauss, 2015), focusing on respondents' memory of their experience, and the underlying memory mechanisms in virtual realm. We collected and assessed the data iteratively so that we could create categories by repeatedly merging, splitting, and relating the empirical themes to one another and to relevant literature (Fischer & Guzel, 2023; Grodal et al., 2021). A total of 40 sub-themes emerged, further combined into 3 main themes (Braun & Clarke, 2006; Weber, 1990) related to our research questions: Memories developed in virtual reality, Competing memory systems, and Comparisons with real-life.

Analysis and findings

As a first theme, participants spoke of both types of memories, highlighting virtual reality's realism and similarity to real-life experience. This brings insight to RQ1 and RQ2. Data suggest that virtual environment was something that participants 'visited' rather than merely watched. For example, R9 recalls: "*I felt like I was there, as a visitor in the museum. It was not simply «I'm watching something», but I really feel like I'm there with him (the tour guide), doing the visit... I told myself «I'm next to him following him on the tour».*"

Generally, the episodic memory was quite salient (RQ1a) as a result of being real-life-like. Participants recalled their experience as a journey, in a particular context and time, reflecting on the experience as a life-like visit:

"*A hostess shows you to a table… and this is when you are instructed to examine the tearoom… Then the waiter directs you to look to your left. And there's some artwork on the wall behind…and then basically she shows you to the table. You sit down and this is when they bring… I want to say that right away they bring the traditional tea tower with the sweet goodies stacked up on it.*" R3.

Taking part in a virtual reality experience is clearly distinguished from an indirect interaction, such as watching a movie about a location, as explained by R15: "*When you see it [Auschwitz] in a movie, you know it's a movie and you could almost think it did not exist, like it's a fiction, or was just constructed for the movie. Seeing it in VR, well, it can raise awareness: look, it exists, it's not just a scene in a movie, it's still there, it's not going anywhere, you know?*" These experiences thus increase the realism of the tourism site, particularly for those who might have lacked real-life experiences before, which might affect memory formation (RQ2).

Further, participants' immersion and interactivity were rich and enabled a strong episodic recall of events (see Johnson & Adamo-Villani, 2010), lending insight to RQ2a regarding the mechanisms that underscore memory formation. This aligns with other research suggesting that the feeling of departure from the real world (i.e., telepresence) influences memory formation (Kim & Biocca, 1997). Experience interactivity acts as a particular memory trigger, as noted by R3, where movement, sight, and interactivity dominated. Notably, R17, who 'visited' the Eiffel Tower in a virtual environment with little interactivity, states that nothing was highly memorable because she could not interact with it much. Thus, analysis reveals the underlying processes that might impact users' memories – virtual reality affordances such as immersion, telepresence, and interactivity.

Concerning semantic memory (RQ1b), tourism experiences in virtual reality created or reinforced brand knowledge, associations, and attitudes (e.g., Johnson et al., 2011; Ochsner & Lieberman, 2001). When asked to recall the brand, participants conveyed brand-related semantic knowledge (e.g., physical aspects, characteristics, and location). R7, for instance, interacted with a destination brand, and formed original semantic-type brand associations, calling the destination "*touristy*", but also mentioning its "*typical*" architecture. The interaction helped participants better remember semantic aspects, including less salient features, further reinforcing existing brand associations and attitudes:

«*It's a spacious museum, big and airy, and I could see it as I remembered it – as well as the light, which I had forgotten. In very little time, I saw things I wanted to see again. On the other hand, <…>I also told myself, seeing the bookshops, "well yes, it is also very touristy", but it's all part of the game.*" R9.

The data also highlighted another theme - competition between memory systems. While the data overwhelmingly indicates, similar to Studies 1 and 2, that virtual reality experiences facilitate accurate semantic and episodic memory formation (RQ1), the qualitative data is more nuanced, hinting at competing memory sysems. As such, participants' ability to list details (i.e., semantic memory) about the brand varied. It appeared that accurately identifying brand elements depended on past interactions with the tourism brand, thus giving additional insight on mechanisms underlying memory formation (RQ2b). For example, Respondent 11, who did not have real-life experience with the tourism site before virtual experience, expressed his semantic memories using general words or common artifacts, whereas Respondent 5, who visited the site before, recalled specific brand names:

"There was also at some point sitting on a bridge, looking at the arena. There was… another square, with like… a statue and the church, very typical. And then… the houses surrounding the square - I don't remember the name." R11.

"I don't remember in which order it was. I think we start with Piccadilly Circus… then we go on to Big Ben. After Big Ben, I think we went to Buckingham Palace (or another place first?). The tube is more or less in the middle… and then we go back to Piccadilly Circus, I think! Or maybe it starts with Piccadilly Circus?" R5.

Interestingly, R5 tends to remember the names of sites well and characterizes the brand in detail, though is more oblivious to the event sequence. In this case, the semantic brand elements stand out, but the episodic memory of the experience is quite weak. This seemed to occur because the experience competed with R5's original visit to London, where the visit order was dissimilar. Moreover, for those who previously visited a tourism site, virtual reality allowed for better recall of those prior visits, and even helped recover 'lost' details so long as it was consistent with the prior visits. This was not something that emerged in quantitative studies, perhaps due to the difficulty in measuring such aspects empirically.

The third theme relates to cognitive comparison, or 'blank-filling', which offers insight on mechanisms that underscore memory formation in virtual reality (RQ2). Data showed that the virtual and prior real-life brand experiences, or expectations of future brand experiences, were continuously compared. Participants who had prior experiences with a tourism brand were more likely to pay attention to details or look for specific objects in their environment and seemed to have a strong sense of telepresence and immersion. They knowingly recalled sensory aspects from a real-life visit and used that to enrich their virtual reality experience, 'filling in the blanks'.

"I've been to quite a few whisky distilleries, and I know what the smell of a malt floor smells like, I think my brain is probably inputting some of that information kind of subconsciously…. I think… there was a lot of internal stuff with me that I could relate to versus if… you've never been to one." R2.

When participants did not visit the site previously in real life, immersion and telepresence still occurred in virtual realm. Aligned with research suggesting that human memories are imperfect, participants who had not physically visited the tourism site reflected on aspects of the visit that did not occur. In some cases, this led to inaccurate memory reconstruction of the virtual reality experience, which has previously been documented in real-life experiences (Bartlett, 1932; Montgomery & Unnava, 2009). Specifically, participants infused their visits with richer sensory details and remembered a more elaborate environment than was part of the virtual experience. Rather than downplaying features of the visit, memories seemed more exciting and affect-laden, consistent with open-ended responses from Study 2.

"I'm trying to remember. I think you could hear… you couldn't really hear a lot of the ocean sounds because you're in a tunnel… but I feel like I did" R14, recalling ambient sounds where there were none.

Finally, memories formed in virtual reality seemed more salient when participants experienced greater attachment to the tourism brand. For those who could not visit the site in real life, but had strong attachment to the brand, memory formation seemed deeper, linking it to a form of nostalgia despite never having visited the site, and providing another potential insight for RQ2a.

"I know a lot about that history and I've studied Anne Frank a lot back in college and in high school. And so it just, it takes you back. But… one could argue… would you have that kind of perspective, just on its own without knowing the history? If you do, I think it makes the experience even more powerful." R13.

Discussion

The data indicate that tourism brand experiences in virtual reality generate both episodic (RQ1a) and semantic (RQ1b) memories. Contrary to prior literature suggesting that the large amount of memory markers generates better episodic memory (Ahn et al., 2009; Optale et al., 2010), or that autobiographic experiences always lead to better recall (Paivio & Csapo, 1971), current research indicates that virtual experience richness can put episodic and semantic memory at odds (RQ1). Specifically, some consumers form strong semantic memories, but weak episodic memories, while others experience the opposite. This is likely due to limited capacity in information-processing (Mayer & Moreno, 2003), and consumers' previous experiences and attachment to the tourism brand (Herz & Brunk, 2017). Notably, memories of the virtual experience were routinely linked to past experiences, when relevant. In some cases, inaccurate recall of the virtual experience occurred, aligned with the reconstructive view of memory (Braun, 1999) and linked to H1. Moreover, these inaccuracies were related to sensory details, which were seemingly important for episodic memory confidence in Study 2.

Concerning RQ2a, virtual reality's realism, interactivity, immersion, ability to instill telepresence, and sensory richness facilitated episodic memory formation. Interactivity particularly influenced episodic memory, and physical action in the tourist journey seemed to encourage memory marker formation. Memories of past experiences infused the virtual experience, making them richer, and uncovering 'lost' details from prior visits. This was particularly true for those with deeper attachment to the tourism brand (RQ2a). Similarly, semantic memories were driven by past experiences (RQ2b). Collectively, we summarize key takeaways, in response to the research questions, below in Fig. 1.
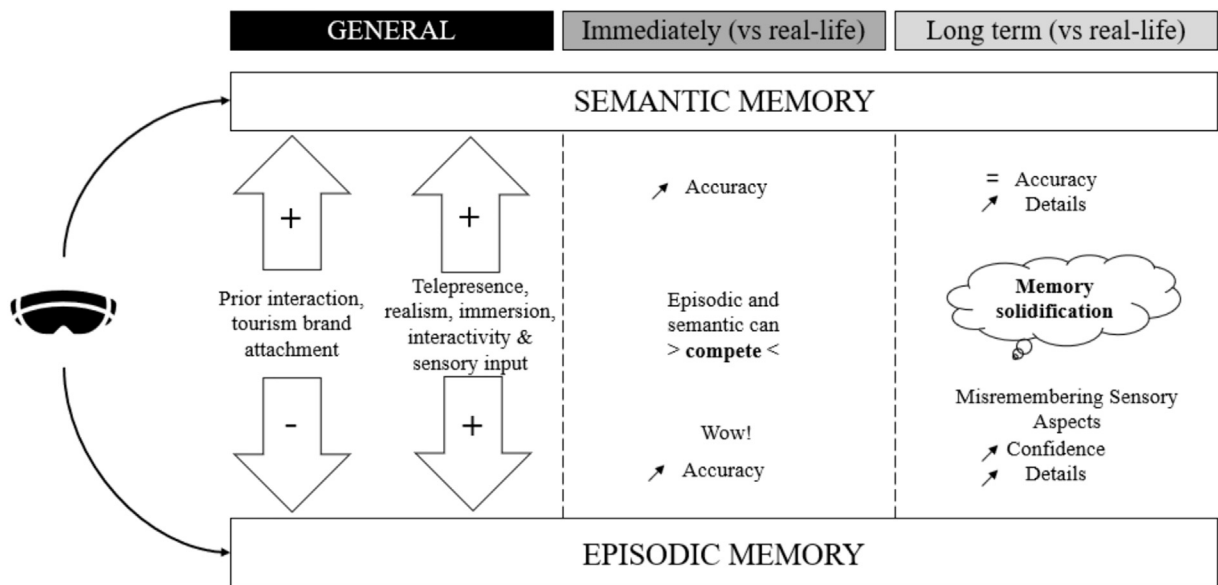
Fig. 1. Findings summary.

General discussion

The results reveal that tourism brand experiences in virtual reality generate lasting episodic and semantic memories. Specifically, accuracy of both types of memories formed in virtual reality is higher than those formed in real-life experiences. Further, confidence in episodic memories is superior in the long-term for tourism brand experiences in virtual reality. However, individuals can seemingly form episodic memories at the expense of semantic memories, and vice versa. For instance, individuals without prior direct brand experiences struggled with an 'overwhelming' experience but were more likely to obtain episodic brand memories drawing from pre-existing semantic associations related to the brand. This corroborates the account of stronger semantic brand memories held by the non-users (e.g. Herz & Brunk, 2017), and adds to the discussion of sensory richness and vividness of immersive technologies (Hyun & O'Keefe, 2012; Warlop et al., 2005).

First, the findings contribute to memory literature, by showing how virtual reality experiences affect memory. The data suggests that episodic memory formation and retention could be a function of 'personal investment' (e.g., tourism brand attachment and prior brand experience). Given that episodic memories are naturally autobiographical (Conway & Pleydell-Pearce, 2000; Tulving, 1972), the self-brand relationship seems crucial for memory confidence and accuracy. Memories formed in virtual reality were not always accurate, but highly related to the sensory-rich aspects of the experience. Over time, episodic memories formed in both virtual reality and real-life decayed and involved mis-remembering sensory details. Yet, there is initial evidence of 'solidification' of semantic memories of the tourism brand over time, which can be further investigated in future research.

Second, the results add nuance to our current understanding of how virtual reality affects memory formation. Current literature assumes that this technology (vs. other brand experiences) increases visit intentions directly because it is an immersive. However, we provide an alternate perspective, showing that it can trigger greater memory confidence, instrumental in decision-making (Aldossary & McLean, 2022; Cowley, 2002; Kerstetter & Cho, 2004; Tung & Ritchie, 2011). Beyond mere novelty, virtual reality provides a wow-moment, reinvigorating prior positive, heightened feelings toward the brand (see Morgan, 2006). Relatedly, tourism brand experiences in virtual reality can facilitate memory formation because of its technical affordances, including telepresence, interactivity, immersivity, and its sensory-rich nature. Importantly, some of these effects are more pronounced in the long-term, after a time delay.

Third, we contribute to tourism literature by documenting how virtual experiences pre- and post-travel can spur memory recall. For participants in pre-travel conditions, while episodic memory was heightened, semantic associations and attitude formation appeared robust over time. These associations have a strong impact on actual tourism decisions (Baumgartner et al., 1992; Schacter et al., 2015). For those with high brand attachment or without real-life experiences, virtual experiences can facilitate deep emotions (e.g., nostalgia) which can provide greater impetus for decision-making. While interviewed participants only indicated the potential for virtual experience to substitute real-life experiences when a visit was impossible or unsafe, it seems that the virtual experience served to trigger future-thinking with regards to visits. As such, it appears that virtual experiences can act as a "place-holder" for future in-person interactions. Additionally, these memories may be a source of comparison for real-life visits. While we did not study the impact of virtual experiences on real-life experiences, it could be that these memories become intertwined. Future research could investigate this more thoroughly. Post-travel, we reveal virtual reality as critical for the creation of lasting memories. Given that memory markers form wow-moments and sensory-rich information represents one way to strengthen memory, we contend that the sensory-rich aspects of virtual reality help to form strong memories, with lasting confidence in these memories compared to real-life experiences. This could impact future experiences with the tourism brand.

Managerial implications

This research has implications for tourism brands. First, brands might deploy virtual reality to create pre-visit memories that will inform decision-making and expectations via memory accuracy and confidence. Some studies demonstrate that persuasive advertising impacts memories of brands and is internalized in consumers' knowledge system in a manner that alters their brand attitudes (Braun, 1999; Braun et al., 2002; Braun-Latour & Zaltman, 2006). As they are immersive and interactive, virtual reality experiences would prompt better memory formation and recall, aiding tourism marketing efforts pre-visit (Ahn et al., 2009; Hyun & O'Keefe, 2012; LaTour & LaTour, 2010).

Moreover, tourism brands might wish to 'reactivate' memories post-visit via virtual reality, affecting future decision-making, brand loyalty, or word-of-mouth. Prior literature suggested postcards or emails as effective techniques (Tung & Ritchie, 2011), but virtual reality's affordances such as telepresence, immersion, and interactivity spur better memory accuracy and confidence, and provide strong emotional responses. For instance, a museum selling tickets online might send customers a virtual exhibit to reactive associated memories, prompting nostalgia.

Providing excessive amount of memory markers in a virtual brand experience can influence memory formation. Features of virtual experience capable of producing episodic and semantic memories should be aligned with the tourism brand's marketing objectives. Because memory types compete, tourism brands should decide whether they want to target associations (i.e., semantic memories) or autobiographical (i.e., episodic) memories. Episodic memories would include sensory-rich information (e.g., more narration, interaction, and scenes) and these might be best suited for pre-traveling (e.g., sampling), especially when consumers take time choosing between tourism brands (Karl et al., 2021). Semantic associations might involve making the brand characteristics stand out in the virtual environment (e.g., greater focus on details, fewer scenes). This could be developed post-visit by helping visitors infuse the virtual experience with memories of their real-life visits, reinvigorating their memories of the tourism brand.

Limitations and future research

This research has limitations due to its exploratory nature. While this work provides insight into the impact of memories and tourism brand experiences in virtual reality, we did not experimentally compare tourism brand experiences in virtual reality pre- and post-visit. We advocate for future research to address this. Additionally, while we rely on extant literature to suggest that memory affects tourists' decision-making, we do not test this explicitly. Future research should measure these outcomes and test the effects of memory in a robust empirical model. Finally, while we compared T1 and T2 memory accuracy and confidence, these were done with a 3- to 4-week delay. Future research should examine the impact of virtual reality (vs. real-life) tourism brand experiences following longer delays. Finally, we did not control the time spent in the field study museum visit, and possible effects of this could be investigated in future research.

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CRediT authorship contribution statement

Alena Kostyk: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Kirsten Cowan:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Laurence Dessart:** Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Michaël Schyns:** Writing – review & editing, Supervision, Software, Resources, Investigation, Funding acquisition.

Data availability

Data will be made available on request.

Declaration of competing interest

The authors do not have any conflicts of interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.annals.2024.103824.

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