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ORIGINAL RESEARCH

# Investigating the impact of autonomy on presence: a comparative analysis on sense of presence and telepresence

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## Abstract

Virtual tourism has great potential for the tourism industry, but physical limitations in sensory experience and the possibility of symbolic images may impact authenticity and the feeling of freedom for tourists. We conduct a study to investigate how vividness, interactivity and autonomy affect tourists' behavioral intention through the sense of presence and telepresence. Findings indicate that vividness and interactivity have a positive impact on tourists' behavioral intention by the mediation of sense of presence and telepresence. Moreover, the results further demonstrate that autonomy exerts a significant impact exclusively on the sense of presence, without affecting telepresence. This study suggests that virtual tour developers should prioritize creating high-quality intermediary experiences by enhancing sensory dimensions and human-machine interaction. Meanwhile, respecting tourists' autonomy and utilizing emerging technologies to enhance the overall enjoyment of the experience is also imperative.

**Keywords** Virtual tourism · Sense of presence and telepresence · Autonomy · Vividness and interactivity

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## 1 Introduction

Due to the impact of the COVID-19 pandemic, the tourism industry has suffered a devastating blow, resulting in approximately 50 million people losing their jobs in 2020, and a cumulative direct loss of $4 trillion in tourism GDP during the period from 2020 to 2021 (UNWTO 2022). Virtual tourism is considered to be a viable alternative to physical tourism, providing an important opportunity to overcome the pandemic by providing remote simulated environments of 3D landscapes for tourism destinations, and playing a key role in helping tourism destinations recover and establish tourism resilience (Kim et al. 2021a). In addition, virtual reality (VR) technology has many tourism-related applications, such as benefiting six aspects including regulation management, accessibility, and cultural heritage protection (Guttentag 2010). Virtual tourism is in a stage of rapid development. According to Statista (2022), the global market size of the virtual tourism industry is estimated to be $5 billion in 2021. This number is expected to increase significantly in the coming years, and the total amount is expected to exceed $24 billion by 2027. A report released by the Research and Markets (2022) shows that the global virtual tourism market is anticipated to reach $1.052 billion by 2030. As immersive technology to become a viable alternative to travelling especially during pandemic (Pratisto et al. 2022), empirical research on virtual tourism experiences and tourists' attitudes towards virtual tourism is of great significance.

However, The relationship between physical information of a real tourism destination and virtual information in the VR environment poses a challenge (Pratisto et al. 2022). While virtual tourism holds great potential for the future of the tourism industry, there are some limitations at the physical level due to technology. This results in virtual tourism being limited in terms of users' perspectives and interactions, as it provides only a snapshot of the tourist destination in terms of time and space. A report on virtual museum tourism indicates that although 3D simulated environments provide a higher level of interaction, users cannot freely move around in virtual space (Fineschi and Pozzebon 2015). Without the ability to fully stimulate our senses in virtual environments, such as being able to "feel", "smell", and "taste", the tourism experience may feel unreal and limited (Mura et al. 2017). Research suggests that authentic experiences in virtual reality significantly impact tourists' cognitive and affective responses, influencing their attachment to VR and their visit intention (Kim et al. 2020). However, current technology has not advanced enough to provide a complete sensory experience, which means that tourists may feel disconnected from their surroundings. This lack of sensory and physical stimulation can create a sense of absence, making it difficult for visitors to fully immerse themselves in the virtual world.

On the other hand, virtual tourism images may be symbolized, resulting in significant deviations from reality. The "tourist gaze" theory proposed by Urry (1992) points out that tourists seek images that match their expectations when visiting tourist sites. For example, the mention of the Forbidden City might evoke images of palaces and gardens, while Shanghai may be associated with the Oriental Pearl Tower. The 3D simulation environment of tourist experience is a complete simulation and synthesis of reality (Loureiro et al. 2020), making it difficult to ensure that virtual

tourism manufacturers will not process and manipulate virtual sites to cater for the expectations of tourists for tourist attractions, thus causing the virtual sites to be symbolized. Previous studies have also mentioned this issue, for example, in a study of virtual tourism in the Middle East, tourists could only watch from pre-assigned viewpoints and were strictly controlled in their movement routes (Leotta and Ross 2018). Some managers of heritage tourism sites refuse this method because they are concerned that the information presented in virtual tourism is unreliable and distorted (Dueholm and Smed 2014). Although virtual tourism shields tourists from negative factors such as crowds and high transportation costs when traveling, it places them in an environment where their experience is limited and it is difficult to guarantee authenticity. Therefore, it is worth exploring whether tourists can gain a free and authentic travel experience in virtual tourism, and whether this experience will affect their behavior.

One key attribute of VR is the sense of presence, wherein users perceive a transition of their physical presence from the real world to the virtual world (Pratisto et al. 2022). Tourists can perceive the virtual tourism destination as a "place" rather than a set of computer images through the realism of the destination conveyed by presence (Slater et al. 1994). Vividness (Lee et al. 2020; Wu and Lai 2021), interactivity (Kim et al. 2023), content and system quality (Lee et al. 2020), innovation and satisfaction (Kim et al. 2020) are considered factors enhancing tourists' sense of presence. Steuer (1992) distinguished between presence and telepresence two decades ago, defining presence as the natural perception of the environment and telepresence as mediated perception of the environment. Yang et al. (2021) defined presence as the mediated experience from a real tourist destination to a virtual one, while telepresence was defined as the subjective feeling of being in the virtual tourism destination. Furthermore, existing research shows that the presence has a positive impact on tourists' experiences. This article attempts to explain the authenticity perceived by tourists through a sense of "being there" in virtual tourism by using the sense of presence and telepresence.

Autonomy is defined as the perception that one's actions are self-determined by their own free will without external interference (Deci and Ryan 1985). In tourism experience, autonomy can be understood as the degree to which tourists are able to independently determine their own behavior and experiences during the tourism activity. Dybsand (2022) reports some advantages of virtual tourism, including providing more temporal and spatial perspectives, reducing external distractions, enhancing visual exploration, and offering a more accessible experience, all of which may lead tourists to perceive higher levels of autonomy. Virtual tourism technology can provide tourists with perfect and even fantasy experiences, which is an important advantage of virtual tourism (Slater and Sanchez-Vives 2016). However, too much synthesized information may hinder tourists' sense of authenticity or limit their visiting experience. As previously mentioned, physical constraints and symbolization in virtual tourism may hinder tourists' autonomy and make them feel restricted. Autonomy as an intrinsic need, plays a pivotal role in influencing tourists' overall enjoyment (Reer et al. 2022). Autonomy may be a crucial concept for tourists, but previous research has predominantly concentrated on its impact on satisfaction or enjoyment (Huang et al. 2016, 2018; Lunardo and Ponsignon 2019; Rahimizhian et al. 2020).

Nevertheless, its influence on the presence remains unclear. Simultaneously, in consideration of real-world challenges, we have incorporated autonomy into our model.

To investigate whether the limitations of virtual tourism in providing a complete sensory experience and the possibility of symbolic images would affect behavioral intention through presence, this paper attempts to address the following questions based on theoretical model: (1) How does the vividness of content, the level of human-computer interaction, and individual autonomy within the virtual tourism environment influence tourists' sense of presence and telepresence, thereby affecting tourists' behavioral intention? (2) How do the sense of presence and telepresence influence tourists' behavioral intention through perceived enjoyment in virtual tourism?

This study has several contributions. First, it offers new perspectives on authenticity in virtual tourism. Yang et al. (2021) have distinguished between the concepts of sense of presence and telepresence, with their research focusing on affective-emotional status, experiences, and psychological stress reduction. On this basis, this study further explores the effects of vividness, interactivity and autonomy of VR technology on sense of presence and telepresence, as well as the impact of sense of presence and telepresence on behavioral intention. The results indicate that the two forms of presence have different degrees of impact on perceived enjoyment and behavioral intention. Second, this study expands on the topic of autonomy in virtual tourism. We discuss the impact of autonomy on both forms of presence and found that autonomy can only influence tourists' sense of presence. One possible explanation is that telepresence is more closely related to the quality, functionality, and reliability of VR technology rather than individual freedom of action. This also substantiates the presence of distinct variances between the two forms of presence. Third, we examine both the direct influence of presence and its mediating impact on behavioral intention through perceived enjoyment. Both pathways have been validated in our results, thus highlighting the mediating role of perceived enjoyment in the process from presence to behavioral intention. We recommend that virtual tourism developers focus on providing high-quality intermediary experiences and immersive sensory experiences, particularly by increasing the richness of information and enhancing human-computer interaction. Moreover, it is crucial to prioritize visitors' sense of autonomy, reduce limitations in virtual tourism, and create a more enjoyable tourism experience.

## 2 Theoretical framework and hypotheses development

### 2.1 Presence theory

Virtual tourism can be defined as the creation of virtual environments by virtual reality technology through providing synthesized or 360-degree real-life captured content (Beck et al. 2019). The key concept for explaining the effectiveness of virtual reality in various usage environments is presence (Tussyadiah et al. 2018). Steuer (1992) proposed two types of experiences in virtual tourism: sense of presence and telepresence. Sense of presence is a natural perception of the environment, while telepresence is a mediated perception of the environment, which can be a real envi-

ronment located far away in time and space or a computer-simulated environment. Minsky (1980) originally defined telepresence as a feeling of "being there", and Lee (2004) defined sense of presence as the psychological similarity between virtual objects and real objects when people experience, perceive, manipulate or interact with them. Previous research has also distinguished presence on different levels. For example, Heater (1992) proposed three types of presence: personal (the extent to which and the reasons why you feel like you are in a virtual world), social (the extent of response from other presences), and environmental (the extent of response from the environment). Similarly, Lee (2004) proposed three types of presence: physical presence (virtual physical objects experienced as real physical objects), social presence (virtual social actors experienced as real social actors), and self-presence (virtual self experienced as real self). Since social presence reflects the authenticity of social actors perceived by tourists and virtual tourism lacks social interaction (Yang et al. 2021), and the focus of this study is on the realism reflected in the destination image, social presence is not explored.

While some studies equate the sense of presence with telepresence, there are still scholars who hold divergent views on this issue. Yang et al. (2021) defined sense of presence as the immersion and experience that users feel in the virtual environment provided by VR technology, while telepresence is viewed as a measurement of a "moment-to-moment" feeling of internal mental imagery of a place generated by the VR technology. Sense of presence is more about mediated experience of a virtual destination from a real tourist destination, while telepresence is more focused on a subjective experience of being present in an environment. On the other hand, Zhu et al. (2022) argue that in Augmented Reality (AR), sense of presence arises from virtual AR experiences of the actual tourist destination, while telepresence is regarded as a subjective sensation originating from the virtual AR-based destination, marked by a transient sensation. Furthermore, Zhu et al. (2023) contend that sense of presence accentuates the feeling of "being there" fostered by comparisons and connections between the actual and virtual environments, while telepresence encompasses a subjective sensation of pure immersion without a connection to the physical environment. In this study, sense of presence reflects the requirement of tourists to obtain the same experience as real tourism destinations in virtual tourism; while telepresence reflects the requirement of tourists to obtain a satisfying mediated experience in virtual tourism. Both types of presence are significantly related to tourist enjoyment and behavior.

### 2.2 Vividness and interactivity

According to Steuer (1992), vividness is defined as the representational richness of a mediated environment, while interactivity is defined as the extent to which users can modify the form and content of the mediated environment in real time, these technological variables are determinants of telepresence. The former reflects the richness and quality of sensory information presented by the communication medium, while the latter reflects the speed and range of interaction within the mediated environment, as well as the mapping of the relationship between users and the medium. Both depend on the technical characteristics and structure of the medium and are necessary

factors in generating presence. Vividness and interactivity are representative of the technological capacity and will produce similar but not identical results in different perceivers (Steuer 1992). In virtual tourism, vividness and interactivity are key driving factors for tourists to feel "being there", and tourists can obtain a better experience by obtaining rich destination information and interacting with the environment.

Virtual tourism comprises three essential elements: visualization, interactivity, and immersion (Yung and Khoo-Lattimore 2017). Sense of presence and telepresence are both defined as forms of immersion, with a distinction lying in whether they are connected to and compared with the real environment (Zhu et al. 2023). Several studies confirm that vividness and interactivity have a positive impact on both forms of presence. For example, an interview about VR tourism demonstrated that the degree of reduction and real-time change of virtual reality in reproducing the real world can impact the sense of scene realism perceived by tourists (Gao et al. 2022). Empirical studies in the field of virtual reality consistently show that vividness and interactivity play a critical role in enhancing both the sense of presence and telepresence. For instance, in a virtual shopping scenario, the positive impact of interactivity and vividness on telepresence was confirmed (Kim J.-H. et al. 2021); in virtual hotel advertisements and virtual shopping scenarios, the positive impact of interactivity and vividness on sense of presence was confirmed (Lyu et al. 2021). Beck et al. (2019) suggests a focus on the technical aspects of research, such as content, design, and interactivity. Therefore, building on results supported by previous research, this article proposes the following hypotheses.

**H1** Vividness in virtual tourism has a positive impact on tourists' sense of presence (a) and telepresence(b).

**H2** Interactivity in virtual tourism has a positive impact on tourists' sense of presence (a) and telepresence(b).

### 2.3 Autonomy

The concept of autonomy, considered one of the three fundamental psychological needs in psychology (Deci and Ryan 1985), has consistently remained a focal point of research in Human-Computer Interaction (Bennett et al. 2023). According to Lunardo and Ponsignon (2019), autonomy refers to the freedom or capacity that consumers possess within a specific context, allowing them the liberty to independently determine their actions within the focal environment, and it is closely intertwined with the notions of ownership and personalization of that environment. People have an inherent desire to make choices and decisions for themselves, and to some extent, virtual tourism provides tourists with the autonomy to freely explore destinations or attractions within a virtual environment. Through such activities, tourists can experience a sense of control over the environment (Li et al. 2022).

Autonomy is regarded as an intrinsic expectation of tourists in virtual tourism (Li et al. 2022), and several studies have provided evidence of its positive impact on consumer emotions. The research by Huang et al. (2018) demonstrates that autonomy

positively influences participants' intrinsic motivation, emotional involvement, and flow in a virtual educational environment. Lunardo and Ponsignon (2019) suggest that autonomy plays a significant role in enhancing tourists' immersion during their travels. This influence may be attributed to potential mechanisms involving temporal dissociation, ultimately resulting in higher levels of tourist satisfaction. When using 360-degree videos, Rahimizhian et al. (2020) found that perceived autonomy significantly influences VR satisfaction. Due to various constraints in virtual tourism mentioned above, tourists may feel that their travel experiences in virtual tourism are limited or are based on the projections of others. Autonomy, by granting tourists the freedom to explore, make decisions, and emotionally engage, allows them to immerse themselves in virtual reality, thereby influencing their sense of presence and telepresence in virtual tourism. Given the numerous beneficial effects of autonomy on user experience (Bennett et al. 2023) and the unclear role of autonomy in presence, we propose the following hypotheses:

**H3** Autonomy in virtual tourism has a positive impact on tourists' sense of presence (a) and telepresence(b).

### 2.4 Sense of presence and telepresence

Behavioral intention is a focal point of interest for tourism researchers (Schiopu et al. 2021). Studies show that behavioral intention encompasses not only the use of a service but also a series of positive reactions that follow. In virtual shopping, behavioral intention is operationalized as consumers' willingness to shop on the application, revisit it frequently, and recommend it to others (Kim et al. 2023). In virtual tourism, Kim, Lee, and PreiKim et al. (2020a, b) define behavioral intention as a target structure that includes the intention to repeat virtual reality experiences, make positive recommendations, and visit attractions experienced in virtual reality. Similarly, Schiopu et al. (2021) argue that behavioral intention includes the intention to use virtual reality in tourism, recommend virtual reality tourism experiences, and pay for virtual reality applications related to tourism.

Research has shown that the sense of presence and telepresence are associated with various positive reactions from users in virtual experiences. Tussyadiah et al. (2018) conducted a study examining the impact of the sense of presence in virtual tourism on tourists' visit intentions. Their findings revealed that the sense of presence during VR cultivates positive attitudes, influences enjoyment, and ultimately fosters elevated visit intentions. Kim J.-H. et al. (2021) demonstrated in a study on virtual reality shopping experiences that telepresence affects consumer perception and enjoyment, further promoting consumer purchasing behavior. Yang et al. (2021) found that both sense of presence and telepresence jointly contribute to the level of satisfaction in 360-degree virtual tourism and reduce the stress caused by COVID-19 through mediation. Zhu et al. (2022) found in their study in the field of AR that both types of presence, sense of presence and telepresence, positively predict satisfaction and subsequently influence tourists' behavioral intentions. Therefore, we propose the following hypotheses:

**H4** Sense of presence in virtual tourism has a positive impact on tourists' perceived enjoyment (a) and behavioral intention (b).

**H5** Telepresence in virtual tourism has a positive impact on tourists' perceived enjoyment (a) and behavioral intention (b).

### 2.5 Perceived enjoyment

Davis et al. (1992) defined perceived enjoyment as the pleasure experienced from the process of using a specific system, without considering any performance outcomes resulting from system use. Perceived enjoyment is commonly regarded as an intrinsic motivation and is positively related to customer behavior (Li and Chen 2019). Existing research suggests that perceived enjoyment has a positive impact on behavioral intention towards virtual products, such as in virtual reality games (Jang and Park 2019), virtual reality shopping (Kim J.-H. et al. 2021), and virtual tourism (Kim and Hall 2019; Li and Chen 2019; Tussyadiah et al. 2018). Tussyadiah et al. (2018) find that the VR enjoyment positively influences attitudes toward the destination, leading to visit intentions. Li and Chen (2019) found that the perceived enjoyment of VR has a positive impact on travel intention, and it is moderated by the anticipated enjoyment of the destination. Through a comparative study of visitors and non-visitors, Kim and Hall (2019) found that enjoyment is a key factor in the pleasure motivation system for continued use of virtual reality tourism. Moreover, whether they are visitors or non-visitors, perceived enjoyment has a significant impact on the flow state, further influencing subjective well-being and continued use. The feelings of pleasure and satisfaction enhance individuals' sense of identification and liking for the activity, increasing their intention to visit real destinations or continue using VR. Therefore, the following hypothesis is proposed:

**H6** Tourists' perceived enjoyment during virtual tourism has a positive impact on their behavioral intention.

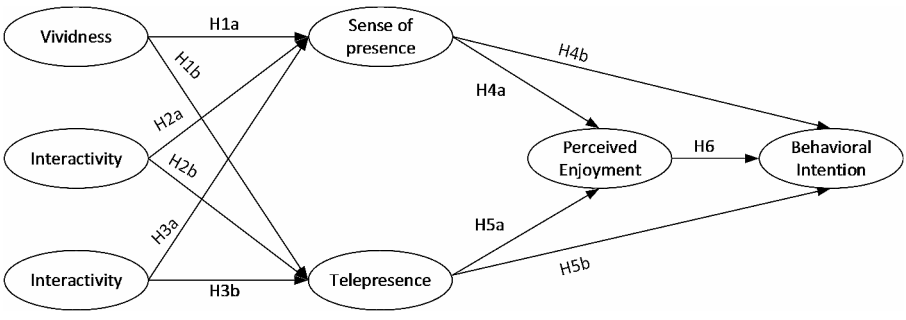


**Fig. 1** Proposed research model

### 2.6 Multiple mediation effects

Based on our hypotheses, this study proposes a multiple mediation model (see Fig. 1). The technological features perceived by tourists during virtual tourism experiences, namely vividness, interactivity, and autonomy, are considered as external stimuli perceived by tourists. Sense of presence and telepresence represent the combined experience that tourists desire to feel fully immersed in virtual tourism. Perceived enjoyment refers to the individual's subjective experience of pleasure or happiness and can be understood as a positive emotional state. This study employs final behavioral intention as a response.

In previous studies, sense of presence and telepresence usually play a mediating role, such as Lo and Cheng (2020) and Kim J.-H. et al. (2021), and both have a positive impact on perceived enjoyment, which in turn promotes behavioral intention, thus forming a multiple mediation effect. Therefore, in addition to the direct effect, this paper also proposes the following mediation hypotheses:

**H7** Sense of presence (a) and telepresence (b) mediates the effect of vividness on behavioral intention.

**H8** Sense of presence (a) and telepresence (b) mediates the effect of interactivity on behavioral intention.

**H9** Sense of presence (a) and telepresence (b) mediates the effect of autonomy on behavioral intention.

**H10** Vividness affects perceived enjoyment through sense of presence (a) and telepresence (b), and thus positively influences behavioral intention.

**H11** Interactivity affects perceived enjoyment through sense of presence (a) and telepresence (b), and thus positively influences behavioral intention.

**H12** Autonomy affects perceived enjoyment through sense of presence (a) and telepresence (b), and thus positively influences behavioral intention.

## 3 Methods

### 3.1 Measures

According to the model hypothesis, there are seven factors in this study, with a total of 28 measurement items designed in the questionnaire. Vividness and interactivity were adapted from the scales of Wu and Lai (2021) and Mütterlein (2018) respectively; to measure autonomy Li et al. (2022) were adopted; to measure; sense of presence, telepresence and perceived enjoyment were adapted from Yang et al. (2021); and behavioral intention was adapted from Schiopu et al. (2022). All the measur-

**Table 1** Confirmatory factor analysis

| Construct | Items | Adopted from |
|---|---|---|
| VI | When I am experiencing the virtual tour, I thought the sensory information was highly vivid. | Wu and Lai (2021) |
| | When I am experiencing the virtual tour, I thought the sensory information was highly rich. | |
| | When I am experiencing the virtual tour, I thought the sensory information was highly detailed. | |
| IA | During experiencing the virtual tour, the VR content allowed me to interact with the virtual world. | Mütterlein (2018) |
| | During experiencing the virtual tour, I had the feeling that I could influence the virtual world of the VR content. | |
| | The VR content of the virtual tour is interactive | |
| AU | When I am experiencing VR tourism, I can freely choose what I want to do. | Li et al. (2022) |
| | When I go on virtual Tours, I don't feel controlled or stressed. | |
| | When I am experiencing VR tourism, I feel that I have a lot of control. | |
| TP | The VR content created a new world for me, and this new world suddenly disappeared when the VR content ended. | Mütterlein (2018); Yang et al. (2021) |
| | When I was experiencing the virtual tour, I felt I was in a tourist destination. | |
| | When I was experiencing the virtual tour, I felt my mind was inside a tourist destination. | |
| | When I was experiencing the virtual tour, I forgot about my physical location. | |
| SP | During experiencing the virtual tour, I felt the normal experience of being in a tourist destination. | Yang et al. (2021) |
| | During experiencing the virtual tour, the destination attraction was the reality for me. | |
| | When I memorized the virtual tour, the images of the destination attraction like the place I have visited. | |
| | During experiencing the virtual tour, I was strongest by the destination attraction or of being elsewhere. | |
| | During experiencing the virtual tour, I often thought to myself that I was actually in the destination attraction. | |
| PE | Using the tourism-related VR activity is enjoyable. | Kim et al. (2021a); Yang et al. (2021) |
| | Using the tourism-related VR activity is pleasurable. | |
| | Using the tourism-related VR activity is fun. | |
| | Using the tourism-related VR activity keeps me happy. | |
| | Using the tourism-related VR activity is exciting. | |
| BI | I want to re-experience the use of virtual reality in tourism in the future. | Schiopu et al. (2022) |
| | I would recommend using virtual reality in tourism to my friends and others. | |
| | I want to tell other people positive things about the content of virtual reality in tourism. | |
| | I would like to visit the place that I saw in the tourism-related VR activity. | |

Note: VI=Vividness; IA=Interactivity; TP=telepresence; SP=sense of presence; AU=autonomy; PE=perceived enjoyment; BI=behavioral intention

able items in this study were evaluated by a 7-point Likert-type scale ranging from strongly disagree (1) to strongly agree (7). Refer to Table 1 for the relevant latent variable construction and sources.

### 3.2 Data collection

To improve readability and accuracy, a preliminary investigation was conducted, and the questionnaire was revised after the initial sample was compiled before being officially launched. The final questionnaire consisted of two parts: the first part included seven dimensions of the sample, and the second part collected demographic variables and asked whether the respondent had experienced virtual tourism. This survey was conducted online using the web-based survey platform Wenjuanwang (https://www.wenjuan.com/) to collect samples in China. The questionnaire platform provides survey form services for both businesses and individuals and is also utilized for academic research. We can access basic information from the collected samples, such as the respondents' IP addresses, geographical locations, and response times, to verify the authenticity of responses (as opposed to automated responses).

Respondents without prior virtual tourism experience were excluded from this study due to their lack of representativeness, as were those under 18 years of age due to non-adult reasons. We then deleted samples with too much same point in their responses to the measurement items (over 60%), and finally selected 610 valid samples.

### 3.3 Data analysis

This survey was conducted in a completely anonymous form, and except for the deception detection questions, which require selecting a specific option, all other questions explicitly stated that there is no correct answer to reduce response bias (Podsakoff et al. 2003). To assess common method bias, this study first employed Harman's single-factor test (Podsakoff et al. 2003). We conducted exploratory factor analysis (EFA) using SPSS 22, and the results identified seven factors with eigenvalues greater than 1, explaining a total variance of 72.90%. The largest factor explained 24.79% of the total variance, which is below the recommended threshold of 50% (Fuller et al. 2016). Therefore, the results of Harman's single-factor test suggest the absence of significant common method bias.

Due to the limited sensitivity of the Harman single-factor test (Fuller et al. 2016; Podsakoff et al. 2003), we also used AMOS 26 to further validate by controlling for the effects of a single unmeasured latent method factor (Podsakoff et al. 2003). Two models were constructed: Model 1, the baseline model, and Model 2, which included a common method factor. Comparing key fit indices between Model 1 and Model 2, observed changes were minimal: $\triangle$RMSEA=0.005, $\triangle$SRMR=0.003, $\triangle$CFI=0.005 and $\triangle$TLI=0.006. All these changes were less than 0.01, indicating that the inclusion of the method factor did not significantly enhance the model fit. Therefore, the results suggest that there is no bias embedded in the responses, and there is no substantial common method bias in the study.

## 4 Results

### 4.1 Profile of the sample

The characteristics of the respondents (see Table 2) were as follows: the male gender ratio was the majority, with 343 males (56.2%) and 267 females (43.8%); the middle-aged and young groups dominated, with 90.0% of the total population aged 18 to 45 years; the educational level of the sample group was relatively high, with about 80% of people having a bachelor degree's or above, and all occupations were involved. the monthly income interval was concentrated between 3000 and 10,000 Chinese Yuan (CNY). Table 2 shows the overall characteristics of the sample.

### 4.2 Measurement model

This study utilized Amos26 and SPSS22 to test the internal consistency reliability, indicator reliability, convergent validity, and discriminant validity of the model (see Tables 3 and 4). All measurement items' loading passed the significance test ($p < 0.001$), and their standardized loading were all greater than 0.7, indicating the validity of the measurement items for the latent variables. The values of the structure reliability (CR) of the factors were all greater than 0.7, and the average variance

**Table 2** Participants' demographic data

| Characteristics | Value | Frequency | Percentage |
|---|---|---|---|
| Gender | Male | 343 | 56.2 |
| | Female | 267 | 43.8 |
| Age | 18–25 years old | 167 | 27.4 |
| | 26–35 years old | 211 | 34.6 |
| | 36–45 years old | 173 | 28.4 |
| | 46–55 years old | 48 | 7.9 |
| | Over 55 years old | 11 | 1.8 |
| Education | ≤High school | 47 | 7.7 |
| | College | 69 | 11.3 |
| | Bachelor | 477 | 78.2 |
| | PhD/Master | 17 | 2.8 |
| Monthly Income (CNY) | Less than 3000 | 56 | 9.2 |
| | 3001–7000 | 380 | 62.3 |
| | 7001–10,000 | 136 | 22.3 |
| | 1001–15,000 | 27 | 4.4 |
| | Over 15,000 | 11 | 1.8 |
| Occupation | Student | 10 | 1.6 |
| | Government | 102 | 16.7 |
| | Professional | 140 | 23.0 |
| | Office | 99 | 16.2 |
| | Service | 153 | 25.1 |
| | Manufacturing | 23 | 3.8 |
| | Agricultural | 74 | 12.1 |
| | Retire | 0 | 0 |
| | Others | 9 | 1.5 |

**Table 3** Reliability and validity of the constructs

| Construct | Items | Mean | S.D. | Standardized loading | AVE | C.R. | Cronbach's Alpha |
|---|---|---|---|---|---|---|---|
| VI | VI1 | 5.03 | 1.16 | 0.788 | 0.585 | 0.808 | 0.809 |
| | VI2 | 4.81 | 1.22 | 0.738 | | | |
| | VI3 | 5.18 | 1.17 | 0.767 | | | |
| IA | IA1 | 5.14 | 1.35 | 0.825 | 0.732 | 0.891 | 0.891 |
| | IA2 | 4.93 | 1.39 | 0.856 | | | |
| | IA3 | 5.31 | 1.32 | 0.884 | | | |
| AU | PA1 | 5.31 | 1.23 | 0.826 | 0.672 | 0.860 | 0.860 |
| | PA2 | 5.17 | 1.26 | 0.822 | | | |
| | PA3 | 5.42 | 1.19 | 0.812 | | | |
| SP | SP1 | 5.40 | 1.12 | 0.774 | 0.610 | 0.886 | 0.886 |
| | SP2 | 5.30 | 1.13 | 0.746 | | | |
| | SP3 | 5.59 | 1.10 | 0.821 | | | |
| | SP4 | 5.16 | 1.15 | 0.780 | | | |
| | SP5 | 5.50 | 1.11 | 0.781 | | | |
| TP | TP1 | 5.50 | 1.07 | 0.818 | 0.598 | 0.856 | 0.855 |
| | TP2 | 5.41 | 1.13 | 0.728 | | | |
| | TP3 | 5.59 | 1.08 | 0.754 | | | |
| | TP4 | 5.34 | 1.11 | 0.790 | | | |
| PE | PE1 | 5.14 | 1.17 | 0.748 | 0.587 | 0.876 | 0.876 |
| | PE2 | 5.08 | 1.20 | 0.793 | | | |
| | PE3 | 5.33 | 1.15 | 0.791 | | | |
| | PE4 | 4.94 | 1.22 | 0.713 | | | |
| | PE5 | 5.22 | 1.23 | 0.781 | | | |
| BI | BI1 | 5.11 | 1.46 | 0.863 | 0.716 | 0.910 | 0.909 |
| | BI2 | 5.00 | 1.44 | 0.870 | | | |
| | BI3 | 5.21 | 1.44 | 0.819 | | | |
| | BI4 | 4.82 | 1.46 | 0.830 | | | |

**Table 4** Constructs inter-correlation and AVE

| Constructs | VI | IA | AU | SP | TP | PE | BI |
|---|---|---|---|---|---|---|---|
| VI | 0.765 | | | | | | |
| IA | 0.387 | 0.856 | | | | | |
| AU | 0.453 | 0.260 | 0.820 | | | | |
| SP | 0.390 | 0.261 | 0.275 | 0.781 | | | |
| TP | 0.297 | 0.272 | 0.120 | 0.196 | 0.773 | | |
| PE | 0.340 | 0.274 | 0.247 | 0.148 | 0.225 | 0.766 | |
| BI | 0.371 | 0.246 | 0.212 | 0.230 | 0.203 | 0.280 | 0.846 |

extracted (AVE) was all greater than 0.5, indicating that the measurement indicators within each factor were well-extracted, and the convergence of the measurement items was good. The Cronbach's Alpha of all factors was above 0.8, indicating the measurable scales were reliable.

As for discriminant validity, the diagonal values in Table 4 represent the square root of AVE and were all greater than the correlation coefficients of other factors, confirming the discriminant validity of the scales.

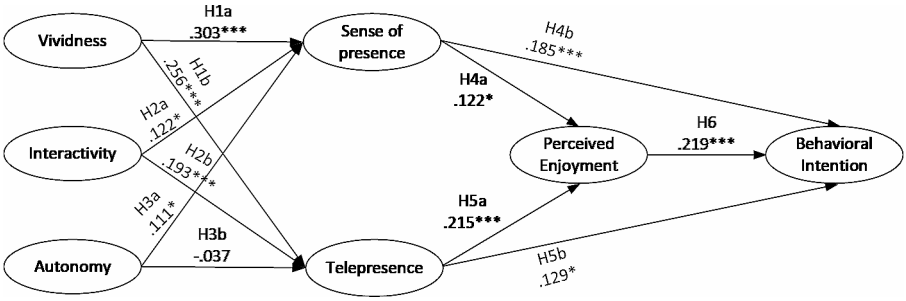


**Fig. 2** The structural model with result. Note: Standerdized coefficients are reported: *$P$<.05; ***$P$<.001

**Table 5** Summary of direct effects

| Hypothesis | Paths | Coefficient (standardized) | S.E. | $P$ | Supported |
|---|---|---|---|---|---|
| H1a | VI→SP | 0.303 | 0.055 | *** | Yes |
| H1b | VI→TP | 0.256 | 0.057 | *** | Yes |
| H2a | IA→SP | 0.122 | 0.035 | 0.010 | Yes |
| H2b | IA→TP | 0.193 | 0.037 | *** | Yes |
| H3a | AU→SP | 0.111 | 0.045 | 0.029 | Yes |
| H3b | AU→TP | −0.037 | 0.048 | 0.484 | No |
| H4a | SP→PE | 0.122 | 0.060 | 0.008 | Yes |
| H4b | SP→BI | 0.185 | 0.065 | *** | Yes |
| H5a | TP→PE | 0.215 | 0.051 | *** | Yes |
| H5b | TP→BI | 0.129 | 0.052 | 0.005 | Yes |
| H6 | PE→BI | 0.219 | 0.066 | *** | Yes |

Note:***$P$<0.01

### 4.3 Structural model

In this study, we use Amos 26 to test the structural model path (see Fig. 2). In terms of model fit. The results of our model are as follows: chi-square ratio = 1.550; AGFI = 0.933; GFI = 0.945; RMSEA = 0.030; CFI = 0.980; IFI = 0.980. They were compared with the recommended values for each indicator, and all met the corresponding critical conditions, indicating a good fit of the model.

This study conducted a hypothesis test on the structural model path using maximum likelihood estimation. Except for H3b, all hypotheses, as indicated by the test results in Table 5, were significant at the 95% confidence level ($p$<0.05). Vividness and interactivity significantly influenced sense of presence (β = 0.303, $p$<0.001; β = 0.122, $p$<0.05), and had a significant impact on telepresence (β = 0.256, $p$<0.001; β = 0.193 $p$<0.001). It is noteworthy autonomy significantly affects the sense of presence (β = 0.111, $p$<0.05), while its impact on telepresence is not statistically significant (β=-0.037, $p$>0.05). H4a, and H5a were supported (β = 0.122, $p$<0.05; β = 0.215, $p$<0.001), confirming that two types of presence had a positive effect on tourists' perceived enjoyment. H4b, and H5b were also supported (β = 0.185, $p$<0.001; β = 0.129, $p$<0.05), indicating that they can promote tourists' behavioral intention. Finally, H6

was supported (β = 0.219, $p < 0.001$), suggesting that the higher the enjoyment of virtual tourism, the more likely tourists are to engage in more behavioral intention.

For the testing of the mediating effect, bootstrap method was used with 5000 resamples to analyze the 95% confidence interval. The results (see Table 6) showed that all mediating paths, except for H9b and H12b, were significant at the 95% confidence level ($p < 0.05$). The results indicate that perceived enjoyment mediates between the two forms of presence and behavioral intention.

## 5 Discussion

The research findings confirm the hypotheses that both vividness and interactivity have a positive impact on the sense of presence and telepresence. Moreover, standardized path coefficients reveal that the effect of vividness on the sense of presence is approximately twice as strong as that of interactivity and has a stronger explanatory power for telepresence. In actual VR tourism experience, vividness may be a more basic stimulus, as vivid images are more likely to evoke tourists' presence. Interactive content often depends on image transformations, and if it lacks support from vivid images, interaction without vivid images may lead to a subpar experience. Additionally, virtual tourism is limited by its inability to provide a multi-sensory experience, which is why some people believe that it cannot replace physical tourism (Mura et al. 2017). The results validate this perspective.

Second, the results indicate that autonomy has a significant impact on tourists' sense of presence, but not on the transition from autonomy to telepresence. This may be attributed to the fact that tourists' perceived autonomy directs them towards the freedom to explore virtual environments, make choices and decisions, much like they would in a real environment. This sense of freedom can enhance individuals' perception of the virtual environment, making them feel more authentically present within it and thus heightening their sense of presence. However, the generation of telepresence does not necessarily rely on a connection with the real environment; instead, it

**Table 6** Summary of mediating effects

| Hypothesis | Paths | Coefficient (standardized) | 95% CI | | *P* | Supported |
|---|---|---|---|---|---|---|
| | | | LB | UB | | |
| H7a | VI→SP→BI | 0.056 | 0.021 | 0.108 | 0.000 | Yes |
| H7b | VI→TP→BI | 0.033 | 0.005 | 0.083 | 0.011 | Yes |
| H8a | IA→SP→BI | 0.022 | 0.004 | 0.054 | 0.014 | Yes |
| H8b | IA→TP→BI | 0.025 | 0.004 | 0.064 | 0.009 | Yes |
| H9a | AU→SP→BI | 0.021 | 0.001 | 0.052 | 0.034 | Yes |
| H9b | AU→TP→BI | −0.005 | −0.030 | 0.009 | 0.388 | No |
| H10a | VI→SP→PE→BI | 0.008 | 0.001 | 0.023 | 0.023 | Yes |
| H10b | VI→TP→PE→BI | 0.012 | 0.004 | 0.030 | 0.001 | Yes |
| H11a | IA→SP→PE→BI | 0.003 | 0.000 | 0.013 | 0.031 | Yes |
| H11b | IA→TP→PE→BI | 0.009 | 0.003 | 0.022 | 0.001 | Yes |
| H12a | AU→SP→PE→BI | 0.003 | 0.000 | 0.012 | 0.043 | Yes |
| H12b | AU→TP→PE→BI | −0.002 | −0.010 | 0.003 | 0.399 | No |

Note: CI = Confidence Interval, LB = Lower Bound, UB = Upper Bound

is more likely closely related to technical factors such as the quality, functionality, and reliability of VR technology. Consequently, tourists' autonomy may not have a significant impact on telepresence.

Third, this study finds that sense of presence and telepresence play different significant roles in tourists' emotions and behaviors. A positive technological experience not only enhances tourist satisfaction but also promotes tourist behavior. Additionally, tourists expect virtual tourism to provide the same experience as visiting real tourism destinations. Some individuals choose virtual guided tours as a way to reconnect with and revisit cherished memories of enjoyable guided tours or destinations they had previously explored (Dybsand 2022). In such cases, a more authentic destination experience significantly influences their usage of virtual tourism because they feel as if they have genuinely been to that destination. On the other hand, technological innovation aids in providing a more immersive experience, enabling them to remotely access destinations without risk and with greater convenience. Higher levels of telepresence lead to a superior immersive experience beyond mere image viewing, thus increasing the likelihood of tourists experiencing enjoyment. As a result, tourists are more likely to use virtual tourism. The presence is a potent predictive factor for subsequent tourist revisits to virtual experiences and even real destinations.

Fourth, the mediating results indicate that the vivid and interactive environment provided by virtual reality technology indirectly affects behavioral intention through the sense of presence and telepresence. However, since autonomy only significantly affects the sense of presence and not telepresence, both H9b and H12b are not supported. Perceived enjoyment is the result of sense of presence and telepresence, and perceived enjoyment significantly affects tourists' behavioral intention, which verifies their chain mediation effect. This study reaches the same conclusion as previous research, suggesting that engagement in virtual tourism may be driven by a hedonic motivation (Kim et al. 2021a; Kim and Hall 2019; Tussyadiah et al. 2018). Perceived enjoyment is usually explained as an intrinsic variable, and in this study, its mediating effect is confirmed, indicating that positive experiences promote tourists' virtual tourism intention.

### 5.1 Theoretical implications

First, whether virtual tourism can replace real tourism remains a subject of significant debate and contention, and whether participants view their virtual experiences as complete in themselves or as temporary substitutes for physical travel experiences is still uncertain (Dybsand 2022). This study reflects on the issue of authenticity in virtual tourism, making contributions to the understanding of the authenticity of virtual tourism and the differentiation of the two modes of existence. Different from previous research, such as sensory measurements of real experience in virtual tourism (Kim et al. 2020), or distinguishing authenticity (Atzeni et al. 2022), this paper introduces two types of presence to measure tourists' perception of authenticity and immersion of VR-based destinations. The empirical research on distinguishing between the two forms of presence is still a relatively new concept, and Dybsand (2022) suggested that we should expand our understanding of the relationships between these terms. By distinguishing sense of presence and telepresence, it provides new perspectives

for researching authenticity in virtual tourism from both technological and individuals' subjective aspects. Meanwhile, building on the research by Yang et al. (2021), this study expands on how technological features of virtual tourism affect tourists' experiences, and tries to deepen the understanding of the psychological mechanism of tourist behavior decisions and consumption experiences. This study confirmed the impact of vividness, interactivity, and autonomy on both forms of presence within the same framework, with vividness having the most significant influence, which is consistent with the perspective of Wu and Lai (2021). It also investigates the influence of these two types of presence on perceived enjoyment and behavioral intention. Furthermore, we further deduce that there is indeed a distinction between presence and telepresence as they are influenced by different factors. These findings contribute to a deeper comprehension of the relationships between these concepts and expanding relevant literature in the field of virtual tourism.

Second, this study contributes to research on autonomy in virtual tourism by exploring how autonomy can affect tourists' sense of presence and telepresence in a virtual environment and its subsequent influence. Prior research has established the positive influence of autonomy on perceived enjoyment and behavior (Huang et al. 2016). Additionally, there is research suggesting that dominance in virtual tourism positively impacts word-of-mouth recommendations and continuous usage intention (Cheng and Huang 2022). These studies emphasize the importance of autonomy and its impact on behavior. Our study builds upon the existing research on autonomy in the field of virtual tourism and explores the impact of autonomy on tourists' sense of presence and telepresence within a virtual environment, thus expanding the literature. Specifically, we discuss how autonomy influences tourists' behavioral intention through the sense of presence and telepresence, and the results indicate that autonomy significantly affects only the sense of presence. By examining the relationships between autonomy and the sense of presence, we gain a more comprehensive understanding of the factors contributing to tourists' enjoyment and behavior in virtual tourism.

Finally, this study extends the research on the mediating role of perceived enjoyment in virtual tourism, highlighting the crucial role of emotional experiences in the consumer behavior process. Previous research has confirms the positive influence of both forms of presence on enjoyment and satisfaction, as exemplified by studies conducted by Zhu et al. (2022) and Zhu et al. (2023) However, the direct impact of these two forms of presence on behavioral intention has remained somewhat unclear. This study not only substantiates the mediating role of enjoyment but also explores the direct influence on behavioral intention, thus contributing to a deeper understanding of the mechanisms through which both sense of presence and telepresence operate within the realm of virtual tourism. Furthermore, our findings align with prior research, such as that conducted by Yang et al. (2021), emphasizing the greater impact of telepresence on perceived enjoyment, and our research further reveals that the sense of presence has a greater influence on behavioral intention.

### 5.2 Managerial implications

This study provides some recommendations for virtual tour developers. Firstly, some developers attract consumers with real experiences, while this study proves that tourists not only expect high-quality intermediary experiences, but also the feeling of being subjectively placed in a real destination. The richness of information and human-machine interaction in virtual tourism has been proven to be significant factors that influence consumers' presence. According to Steuer (1992), development companies can consider expanding the sensory dimension in virtual tourism, introducing new sensory experiences, such as real sounds in the natural environment, humidity, and smell. They can also increase sensory depth, such as providing higher resolution and more stereoscopic images and richer details visually. On the other hand, the human-machine interaction currently provided by VR technology is still limited. Improving users' ability to control and modify content in virtual reality environments or expanding interactive forms can also enhance tourists' sense of immersion.

Second, tourists' sense of autonomy in virtual tourism has a significant impact on their overall experience. While autonomy does not have a significant impact on telepresence, it can still influence tourists' emotions and behaviors through sense of presence. This highlights the importance for virtual tourism developers to not simply present destinations to tourists, but also fully respect their sense of autonomy. When designing virtual tourism experiences, it is essential to consider tourists' autonomous experience and sense of control to enhance the overall attractiveness and user experience. These result support the view that developers need to focus on a human-centered design approach and provide high-quality human-computer interaction systems (Stankov and Gretzel 2020).

Finally, developers of virtual reality tours can increase consumers' usage of virtual reality tourism by enhancing their enjoyment. To achieve this, developers can utilize emerging technologies such as artificial intelligence and augmented reality to provide tourists with a sense of novelty and exploration, immersing them in virtual tourism scenes. This approach can help to relieve tourists psychologically, improve their satisfaction, and enhance the attractiveness and user stickiness of virtual reality tourism, leading to increased revenue and user base.

### 5.3 Limitations

There are several noteworthy limitations to this study. The sample was obtained solely through online surveys in China, and therefore the results may not be applicable to other countries, limiting the generalizability of the findings. Additionally, the measurement items relied on tourists' recollection of past virtual tourism experiences, which may introduce information bias and lead to inaccuracies in the data.

This study still has expandable directions in the future. The limitations of virtual tourism may be physical or cultural. However, this article does not directly distinguish the limitations in virtual tourism. In the future, the limitations of virtual tourism can be refined, and different limitations can be explored for how they affect consumer experiences. Moreover, given that virtual tourism may hold greater significance for

individuals with mobility issues, future research should focus on exploring the willingness of the elderly group to participate in virtual tourism experiences.

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## Declarations

**Conflict of interest** The authors have no known conflict of interest to declare that are relevant to the content of this article.

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