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EFFECTS OF EMOTIONAL AND COGNITIVE RESPONSE TO HERITAGE ON TOURIST DESTINATION IMAGE: A COMPARISON OF OBJECTIVE AND SUBJECTIVE MEASURES

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ABSTRACT

This study aims to examine the Tourist Destination Image construct in destinations with historical and architectural heritage by applying and comparing two different techniques, experimentation using neuromarketing techniques and measures, and survey using multi-item scales. Both techniques measured the cognitive and emotional responses of participants who experienced virtual realities of tourist destinations with architectural heritage. In the case of the experimentation, we applied neuroscience techniques to observe and measure brain responses in alpha and beta bioelectrical waves using an electroencephalogram. In the case of the survey, the questionnaire included a multi-item scale to measure the cognitive and emotional dimensions of the image of the virtual destinations. The results indicate that the virtual experience of historical and architectural heritage intensively and positively impacts Tourist Destination Image formation. The measure based on the multi-item scale seems to offer better explanatory and predictive results. However, this result may be due to methodological limitations.

Keywords: Virtual reality; historical and architectural heritage; tourist destination image; cognitive and emotional responses, neuromarketing, measurement scales

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Efectos de la respuesta emocional y cognitiva al patrimonio en la imagen del destino turístico: Una comparación de medidas objetivas y subjetivas

RESUMEN

Este estudio tiene como objetivo examinar la formación de la imagen de destino turístico de destinos con patrimonio histórico y arquitectónico utilizando y comparando dos técnicas diferentes, la experimentación, aplicando tecnicas y medidas de neuromarketing y la encuesta aplicando escalas de medida multi-item. En ambas técnicas, medimos las respuestas cognitivas y emocionales de los participantes que experimentaron realidades virtuales de destinos turísticos con patrimonio arquitectónico. En el caso de la experimentación, aplicamos técnicas de neurociencia para observar y medir respuestas en ondas bioeléctricas cerebrales alfa y beta mediante un electroencefalograma. En el caso de la encuesta, el cuestionario incluía una escala multiítem para medir las dimensiones cognitivas y emocionales de la imagen de los destinos virtuales. Los resultados indican que la experiencia virtual del patrimonio histórico y arquitectónico impacta de manera intensiva y positiva en la formación de la imagen del destino turístico. La medida basada en la escala multiítem parece ofrecer mejores resultados explicativos y predictivos. Sin embargo, este resultado puede deberse a limitaciones metodológicas.

Palabras clave: Realidad virtual; patrimonio histórico y arquitectónico; imagen del destino turístico; respuestas cognitivas y emocionales, neuromarketing, escalas de medición.

1. INTRODUCTION

Tourism destination image (TDI) is a key construct and concept in tourism research and marketing. It refers to the perceptions that tourists, or potential tourists, hold about a specific destination. Over the past few decades, this construct has been extensively studied and recognized as a multidimensional concept, composed of both cognitive and emotional components (Beerli-Palacio and Martín-Santana 2017; Elliot and Papadopoulos 2016; Huete-Alcocer et al. 2019; Kani et al. 2017; Lai, Wang, and Khoo-Lattimore 2020; Hosany, Martin, and Woodside 2021)

The global tourism industry experienced a major slowdown due to the COVID-19 pandemic (Buckley and Cooper 2021). However, tourists' perceptions continue to play a crucial role in the industry's recovery (Jangra, Kaushik, and Saini 2021; Serrano-Arcos, Sánchez-Fernández, and Pérez-Mesa 2021). Nowadays, tourists can explore travel experiences through various multimedia platforms (Lupu et al. 2021). The global consumption of multimedia content is rapidly increasing, and the rise of virtual tours is generating new questions in tourism marketing and destination management (Palazzo et al. 2021).

According to Dongkyun Kim *et al*. (2017) understanding the interaction between culture and tourism is both fascinating and essential; however, further conceptual exploration is needed (Duignan 2021). This need extends to TDI measurement methodologies and scales, which offer a wide range of procedures and tools due to the diverse nature of tourism destinations (Garzon-Paredes and Royo-Vela 2021). Currently, limited research within the TDI framework integrates virtual reality, neuroscience, multi-item scales, and structural equations to examine image formation in cultural destinations with heritage elements.

Data on Spanish tourism highlight the significant role that culture and historical heritage play in the appeal of tourist destinations. Consequently, a substantial portion of the tourism offering is centred around culture and heritage (Huete-Alcocer, López-Ruiz, and Grigorescu 2019; Huete Alcocer and López Ruiz 2019). Intangible and tangible cultural elements — such as historical and architectural heritage — can enhance cognitive and emotional responses to a destination. This, in turn, positively influences the destination's image, thereby increasing its attractiveness and competitiveness (Hernández, Duarte, and Folgado 2016; Folgado-Fernández et al. 2024; George 2017; Royo-Vela, 2009. Furthermore, the cognitive and emotional aspects of Tourist Destination Image (TDI) can be explored by examining visitors' responses to the historical and architectural heritage of cities and towns (Royo and Serarols 2007; Royo-Vela 2009; Royo-Vela and Garzón-Paredes 2023)

The general objective of this study is twofold; first, it aims to evaluate the impact of historical heritage on tourists' cognitive and, more importantly, emotional responses, and to analyze how these responses influence the overall image of a tourist destination; second, it seeks to compare the effectiveness of two different approaches for measuring the emotional and cognitive dimensions of the destination image. The first approach utilizes neuroscientific techniques, such as electroencephalography, to assess cognitive and emotional responses to tourist stimuli; the second approach involves analyzing responses to a series of variables collected through questionnaires, which reflect the destination image's emotional and cognitive dimensions. The overarching hypothesis is that historical and architectural heritage positively influences the formation of a destination's image through the emotional and cognitive responses generated by the visitor.

2. LITERATURE REVIEW AND HYPOTHESIS SETTING

Destination image is of great importance for tourism researchers and managers as it motivates tourists' interest, satisfaction, loyalty, or intention to behave (Garzón-Paredes and Royo-Vela 2021)(Shafiee, Tabaeeian, and Tavakoli 2016); it is a constantly changing construct that is understood as a subjective representation, feeling, and cognition about a destination and consists of three elements: the cognitive dimension of the image, the emotional dimension of the image, and the overall image of the destination (Baloglu and Brinberg 1997; Baloglu and Mccleary 1999; Baloglu and McCleary 1999; Beerli and Martín 2004; Tasci, Gartner, and Tamer Cavusgil 2007; Nghiêm-Phú 2014; Mak 2017; Royo-Vela 2006, 2009). In short, the essence of TDI is a cognitive-emotional structure or system related to something substantial such as a place or destination.

An important body of research in the tourism marketing literature (Phú 2015; Mak 2017; Royo-Vela and Garzón-Paredes 2023) tends to consider that image is a construct generated through the cognitive and emotional interpretation of the consumer and results from the combination of two components that are closely related to each other: on the one hand cognition includes perceptions, beliefs, knowledge, thoughts, cognitive responses generated by individuals based on a basket of attributes that correspond to resources, attractions, facilities, infrastructure, cultural, historical heritage, and social factors or general tourism services available at the destination (Stabler 1995; Alhemoud and Armstrong 1996; Garcia, Gomez, and Molina 2013; Gómez, García, and Molina 2013). On the other hand, emotion includes emotions that can be observed through the emotional response toward the first component or the destination itself. The relationship between cognitions, and emotions, and the overall image of a tourism destination is hierarchical or sequential, i.e. the cognitive component affects the overall image directly and indirectly through the emotional component, and, in turn, the emotional component influences the overall image (Baloglu and Mccleary 1999; Stylidis, Cherifi, and Melewar 2021; Nghiêm-Phú 2014)

The measurement of TDI shows a heterogeneity of approaches and methods (see Table 1). Echtner and Ritchie 1991 explain that destination image research relies heavily on quantitative studies using structured questionnaires; these authors emphasize that qualitative research is necessary to capture a complete list of image attributes; they suggest the use of a combination of qualitative and quantitative methodologies to fully operationalize the image construct (Royo-Vela 2006, 2009); multi-item scales can be developed to measure cognitive and emotional components, and open-ended questions or single-item scales can be used to measure holistic and/or unique characteristics of a destination.

Two structured approaches predominate when measuring the image of a destination; the first is based on individuals' evaluation of a destination based on a list of attributes that characterize it; the evaluation request can take place before, during, or after the visit (Galí Espelt and Donaire Benito 2005;Royo-Vela and Garzón-Paredes 2023); the second approach has the same basis as the first but also includes scales to establish the importance of the attributes for the respondents.

Table 1 summarizes the research variety on measuring tourism destination image - countries, regions within countries, cities, and towns - including the number of items used and the type of measurement scale.

Table 1
RESEARCH METHODOLOGY APPLIED FOR MEASURING TDI AND COMPONENTS SINCE 1990

Author	Methodology
Fakeye and Crompton (1991)	Structured: - 32 attributes - *Likert-type scale* (7 points)
Gartner and Shen (1992)	Structured: - 22 attributes - *Likert-type scale* (5 points)
Walmsley and Jenkins (1993)	Structured: - 6 attributes - semantic differential scale (7 points)

Author	Methodology
Echtner and Ritchie (1993)	Unstructured: - 3 Open questions describing the holistic component: functional, psychological, and singular. Structured: - 35 attributes for measuring functional and psychological components - *Likert-type scale* (6 points)
Alhemoud and Armstrong (1996)	Structured: - 33 attributes - *Likert-type scale* (5 points)
Baloglu and McCleary (1999)	Structured: - 14 image attributes to measure perceptual or cognitive - *Likert-type scale* (5 points) - semantic differential scale items 3 and 7 points to measure the affective component - Scale of 1 item semantic differential and 7 points to measure the overall image
Martín and Beerli (2004)	Structured: - 24 attributes (the cognitive component). *Likert-type scale* (7 points) - 2 attributes (affective component). Semantic differential (7 points) - 1 global image. *Likert-type scale (7 points*)
Royo-Vela (2006, 2009)	Structured: - 34 attributes (cognitive and affective components). *Likert-type scale* (7 points) - 4 attributes (overall affective component). Semantic differential (7 points) - 1 Global image. *Likert-type scale* (7 points)
García and Bigné (2001)	Structured: - 22 attributes (11 functional 4-mixed 7 psychological). Likert-type scale (5 points) -A global image. Likert-type scale (5 points)
del Bosque and San Martín (2008)	Structured: - 22 attributes (the cognitive component). *Likert-type scale* (7 points) - 4 attributes (affective component). Semantic differential (7 points)
Gómez, García, and Molina (2013)	Structured: - 23 attributes (the cognitive component). *Likert-type scale* (10 points) - 1 global image. Likert type scale (10 points) 1 comparative Image. Likert-type scale (10 points)

Author	Methodology
Garzón-Paredes and Royo-Vela (2021)	Structured: 5 attributes (cognitive component). *Likert-type scale* (7 points) - 5 attributes (emotional component) *Likert-type scale* (7 points)
Royo-Vela and Garzón-Paredes (2023)	Structured: - 17, 15, 31 attributes (cognitive and emotional components). *Likert-type scale* (7 points) - 2 attributes (overall emotional component). Semantic differential (7 points) - 1 Global image. *Likert-type scale* (7 points)

Source: (Echtner and Ritchie 1993; Beerli and Martín 2004; Bigné, Sanchez, and Sanchez 2001;Royo-Vela 2006, 2009; Garzón-Patredews and Royo-Vela 2021; Royo-Vela and Garzón-Paredes 2023).

More recently, and complementary to self-reports or questionnaire responses, the use of psychophysiological techniques allows real-time measurement of physiological and brain responses to stimuli (Bastiaansen et al. 2018); as well as the identification of which tourist visual stimuli are most successful in eliciting emotional responses (Shanshi, Scott, and Walters 2014; Skavronskaya et al. 2017; Moyle et al. 2019; Hadinejad et al. 2019; Royo-Vela and Garzón-Paredes 2023). Images evoke stronger affective responses than verbal representations (Michael et al. 2019)

Among these neuromarketing techniques, electroencephalogram (henceforth EEG) stands out for its suitability to investigate marketing or tourism stimuli and emotional responses to them (Luck 2014; Garzón-Paredes and Royo-Vela2022)

According to Michael *et al*. (2019) brain scanning can be used to understand better the underlying unconscious emotional and cognitive processes that affect consumer thought and action. Bastiaansen *et al*. (2018) who investigated emotional responses to destination images, including films of popular destinations as stimuli, concluded that EEG-based neuromarketing is a valuable tool for evaluating the effectiveness of destination marketing or for tourism research (Bastiaansen et al. 2022); in addition Michael *et al*. (2019) used neuroscience methods such as EEG and fMRI to investigate unconscious emotional and cognitive responses to tourism images; these techniques provided information about emotional and cognitive responses that occur outside of conscious information processing, offering a more objective and accurate measure of emotional responses than traditional or more subjective ones (Michael et al. 2019; Bastiaansen et al. 2018; 2022)

Together with neuromarketing techniques, virtual reality (VR) technology has managed to offer a more immersive experience that closely resembles reality; VR allows people to have virtual experiences like reality and perform various tasks using simulated scenes (Hyun and O'Keefe 2012), and can be exciting, fun and increase motivation (de Rooij, van de Port, and Meijer 2016).

When the product is a destination, image creation is critical as the tourist cannot try the product before buying it; virtual reality allows to decrease this limitation (Guttentag

2010); thus, it is interesting to investigate the tourist's behavior through stimuli that emulate a possible visit to a destination endowed with cultural heritage and then evaluate the cognitions and emotions in the human mind (Sirgy and Su 2000); for this purpose, it is possible to use the advantages of navigability in a virtual travel experience (Zhou and Lin 2012); it is known from previous studies that virtual reality significantly influences the emotional and cognitive dimensions of the experience (Choi, Hickerson, and Kerstetter 2018; Garzón-Paredes and Royo-Vela 2022) which facilitates the investigation of concepts and constructs (Choi and Cai 2017; Sirgy and Su 2000).

These developments have profound implications for tourism marketing, tourism research, and potentially for cultural heritage preservation (Bastiaansen et al. 2018; Flavián, Ibáñez-Sánchez, and Orús 2021; Yuce et al. 2020; Lakshmi and Ganesan 2010; Kim, Lee, and Jung 2020; Trang et al. 2023; Kang et al. 2020)

In addition, virtual reality provides the opportunity to generate alternative useful experiences for heritage conservation. Thus, virtual reality (VR) has become a valuable tool for cultural heritage research and conservation, as it allows for the recreation of historical and cultural settings (Zaragoza-Siqueiros et al. 2019); it can also be used to model and document architectural heritage, leading to a better understanding of its history and the implementation of conservation measures (Hassan and Xie 2020); this visual stimulation can be studied quantitatively to detect the effect of heritage architecture on cognitive and emotional responses and the image of the tourism destination (Lakshmi and Ganesan 2010; Kim, Lee, and Jung 2020)

Based on these results found in previous research on the TDI construct and measurement - subjective or objective -, the relationships between cognition, emotion, and Tourist Destination Image, and the use of virtual reality of the tourist destination as a stimulus, these 6 hypotheses (see Figure1) and a research question are posed:

Model 1: measuring the cognitive and emotional component of the image using EEG

H1a: Cognitive response to the heritage destination positively influences the image of the heritage destination.

H2a: Cognitive response to the heritage destination positively influences the emotional response to the heritage destination.

H3a: Emotional response to the heritage destination positively influences the image of the heritage destination.

Model 2: measuring the cognitive and emotional component of the image using multi-item scales

H1b: The cognitive component of the image positively influences the destination image.

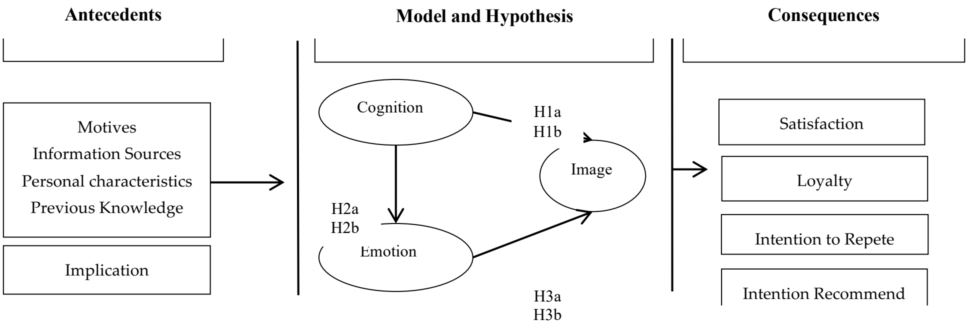
H2b: The cognitive component of the image positively influences the emotional image component.

H3b: the emotional component of the image positively influences the destination image

As previously stated, we can find in the literature on the one hand subjective approaches such as multi-item scales and self-reports to measure TDI, and on the other hand the use of psychophysiological techniques that allow real-time objective measurement of physiological and brain responses. Therefore the following research question is proposed:

Which is a better measure of the image of the heritage destination, objective or subjective?

Figure 1
MODEL AND HYPOTHESIS



Source: the authors themselves

3. MATERIALS AND METHODS

The present study employs an experiment utilizing neuromarketing techniques, including electroencephalography, surveys, and virtual reality, with a randomly selected sample of 25 individuals, the participants, aged between 21 and 60, were residents of Latin America with university-level education, none of whom were familiar with the destinations being investigated (Gholami Doborjeh, Doborjeh, and Kasabov 2018); These "virtual tourists" had no prior knowledge of the tourist destinations or the heritage sites or assets they would be exposed to; all individuals who participated in the experiment afterward completed the survey.

It is important to note that neuromarketing is a discipline focused on researching how the human brain behaves concerning consumer decisions; a distinctive feature of neuromarketing is its reliance on small sample sizes, based on the premise that the human brain behavior follows universal patterns that can be generalized to the wider population; therefore, large sample sizes are not required to yield meaningful results (Clément et al. 2022; Lee, Broderick, and Chamberlain 2007; Liang et al. 2015; Morin 2011); additionally, neuromarketing techniques are costly and require specialized equipment, making small samples a practical approach to optimizing available resources.

Table 2
DEMOGRAPHIC PROFILE OF STUDY PARTICIPANTS

Participant ID	Gender	Age Range	Education Level
1	Male	18 to 23	Graduate
2	Female	18 to 23	Graduate
3	Male	18 to 23	Graduate
4	Male	Over 41	Postgraduate
5	Female	18 to 23	Graduate
6	Male	24 to 29	Postgraduate
7	Male	18 to 23	Graduate
8	Female	18 to 23	Graduate
9	Male	30 to 35	Postgraduate
10	Female	24 to 29	Postgraduate
11	Male	24 to 29	Postgraduate
12	Female	18 to 23	Graduate
13	Female	18 to 23	Graduate
14	Female	30 to 35	Postgraduate
15	Male	30 to 35	Postgraduate
16	Female	24 to 29	Postgraduate
17	Female	18 to 23	Graduate
18	Female	24 to 29	Postgraduate
19	Male	18 to 23	Graduate
20	Male	36 to 40	Postgraduate
21	Female	18 to 23	Graduate
22	Male	18 to 23	Graduate
23	Female	Over 41	Postgraduate
24	Male	24 to 29	Postgraduate
25	Female	24 to 29	Postgraduate

3.1. Materials and Procedure

The data collection took place in a physiological laboratory equipped with electroencephalogram, virtual reality (VR) goggles, a headset, and an iPhone smartphone; the smartphone was inserted into a VR device to display videos of tourist sites featuring architectural heritage, allowing the brain's responses to these stimuli to be captured via an electroencephalogram; at the end of the experiment, each participant completed an electronic questionnaire using a scale designed to measure the image of the tourist destination, specifically adapted for cultural destinations; the scale, presented in Table 2, is based on the heritage destination measurement scale developed, applied, and validated by (Royo-Vela 2006, 2009).

Table 3
SCALE FOR MEASURING TDI COGNITIVE AND EMOTIONAL DIMENSIONS

Code	Observables-variables.	Dimension
C1	It is a place with notorious elements.	
C2	It has a variety of monuments.	
C3	It is a place with a wealth of heritage.	Cognitive
C4	It is a place with a wealth of history.	
C5	It is a place with diverse artistic or architectural styles.	
E1	I have had the feeling of personal or intellectual enrichment.	
E2	I had the feeling of disconnecting, of being in a different and refreshing place.	
E3	I had the feeling of living something authentic.	Emotional
E4	I have had a feeling of admiration for past architecture and preservation over time.	
E5	I have had the sensation of being filled, of being enriched.	

Adapted from Royo-Vela (2006, 2009)

3.2. Electroencephalogram and waves studied

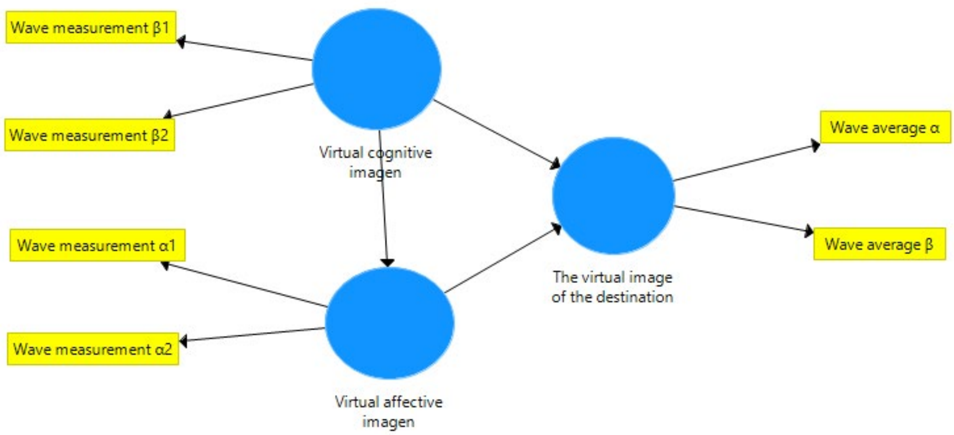
EEG (Electroencephalography) is a graphic recording of rhythmic brain activity, arranged in various timelines, known as channels, that correspond to specific brain areas from which the data is collected; in simpler terms, electroencephalography equipment provides a record of brain rhythms obtained through electrodes placed on the scalp, which are electronically amplified; this creates a record that allows for visualization and analysis (Garzón-Paredes and Royo-Vela 2022).

A typical EEG recording consists of multiple horizontal traces, each representing a channel, where the oscillations per second correspond to different brain rhythms or waves (Fallani et al. 2008; Astolfi et al. 2008; Cincotti et al. 2008); brain waves—delta, theta, alpha, beta, and gamma—coexist and vary in frequency depending on the amount of electrical activity generated by stimuli; these are measured in Hertz (Hz); in this experiment, alpha and beta waves were observed. Alpha (α) waves, ranging from 8 to 12 Hz, represent emotional responses; beta waves, ranging from 12 to 30 Hz, result from heightened neural activity and means more complex brain processes, such as consciousness and concentration, indicating cognitive activity (Astolfi et al. 2008; Candia Rivera 2016): these waves represent more complex brain activity related to states of consciousness and concentration and represent cognitive activity.

To obtain quantitative data, the alpha (8 Hz to 12 Hz) and beta (12 Hz to 30 Hz) combinations from all channels were first captured, two wave points were then randomly selected from each range (alpha and beta) of the combined waveforms (Candia Rivera 2016); this information was collected for analysis using structural equation modeling.

The structural model comprises three components: cognition, emotion, and image; beta points are associated with cognition, alpha points with emotion, and the image is a composite of cognition and emotion; this construct is generated by averaging the alpha and beta waves (see Figure 2); in other words, the metric data for the observable variables in the structural model are derived directly from the participant's brain activity.

Figure 2
TDI STRUCTURAL MODEL



3.3. The multimedia stimulus of virtual reality

Each participant in the study is immersed in video clips showcasing tourist destinations featuring representative and well-known historical or heritage architecture sites, viewed through virtual reality goggles. These heritage architecture sites and assets include monuments, spaces, buildings, squares, and facades located in cities in the center and northwest of Spain and representatives of the Roman, Romanesque, Gothic, and Renaissance architectural styles. An electroencephalogram (EEG) is placed on the participant's head to collect data directly from the scalp; this setup, combined with electroencephalography, responses to a questionnaire using a measurement scale, and subsequent structural equation modeling, allows the study to measure the cognitive and emotional impact of historical and cultural architectural heritage on the formation of the destination's image; The Spanish virtual destinations evaluated in this research, along with their respective projection times in the VR devices, are listed in Table 4.

Table 4
VIRTUAL DESTINATIONS VIEWED BY SUBJECTS

Cumulative time. Start-end	Destinations and assets
00:00-00:37	Plaza de la Santa Cruz
00:37-01:39	Plaza mayor de Madrid
01:39 -02:00	Knifemakers' Arch
02:00-02:30	Doors of the San Miguel market
02:30 -03:01	Main Street and Church of the Sacramento
03:01-03:33	Plaza de la Villa
03:33-04:02	Segovia Viaduct
04:02-04:33	Temple of the Patron Saint of Madrid
04:33 -04:59	Armory Square
04:59-05:23	The site of the Plaza de la Armería
05:23-05:54	Royal Palace of Madrid
05:54 -06:19	Centre of the Plaza de Orient
06:19 -06:50	Monastery of the Incarnation
06:50-07:21	Ramales Square
07:21-07:48	Santiago square
07:48 -08:15	La Adrada Castle
08:15-09:15	León, Spain
09:15-10:15	Booty House
10:15-11:11	Basilica of San Isidro
11:11-12:08	León Cathedral
12:08 -13:06	Straw Square

3.4. Structural Equation Modelling. PLS procedure and data adequacy

Structural Equation Modeling (SEM) using the Partial Least Squares (PLS) approach is particularly advantageous for explaining or measuring the effect of exogenous latent factors on endogenous latent factors, especially when small sample sizes are involvedChin 1998; Marcoulides and Saunders 2006).

According to Chin (1998), the minimum required sample size for this type of research is 20 units or ten times the largest number of independent factors affecting the dependent variable. SEM-PLS is a regression technique that models relationships between latent variables using principal components and regression analysis. This study uses SEM-PLS to examine the effects of cognition and emotion (exogenous factors) on image (the endogenous factor). The coefficient of determination (R^2) was employed to evaluate the explanatory power of the independent variables on the dependent variable.

The software used for this analysis was SMART-PLS (Ávila and Moreno 2007). SMART-PLS also enabled Blindfolding analysis, a resampling technique used to calculate Stone-Geisser's Q^2 test values. A Q^2 value greater than zero for an endogenous latent variable indicates that the model is relevant for the construct, and a value of zero or less means that the model lacks predictive capability.

Additionally, the study applied full bootstrapping with 5000 subsamples, using a bias-corrected and accelerated (BCA) bootstrap confidence interval method. A two-tailed test with a significance level of 0.05 was employed, along with path weighting (Path), a maximum of 5000 iterations, and a stopping criterion of 10−X=710^{-X} = 710−X=7.

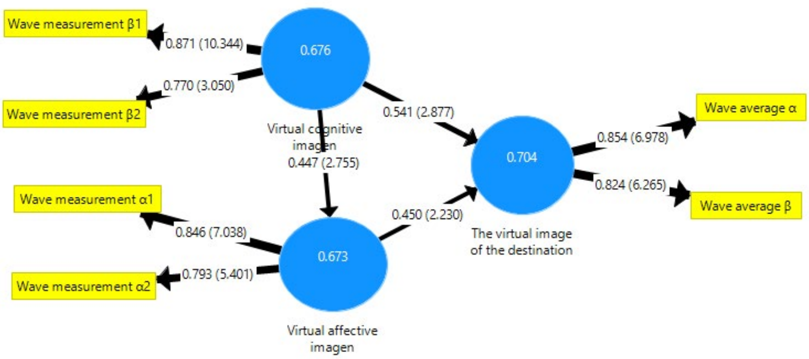
In this research, the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach was chosen due to its suitability for analyzing small samples and non-normally distributed data; unlike Covariance-Based SEM (CB-SEM), PLS-SEM focuses on maximizing explained variance and does not require strict assumptions of multivariate normality, providing greater flexibility in exploratory and predictive studies (Hair et al. 2017). Moreover, its robustness in handling small sample sizes and producing stable estimates in these scenarios makes it a valuable tool when CB-SEM is not appropriate due to insufficient sample size (Hair et al. 2019; Chin 1999). Additionally, considering that neuromarketing studies using electroencephalogram (EEG) techniques often work with relatively small samples, the sample size of 25 participants in this study is appropriate; previous research in neuromarketing has shown that sample sizes between 20 and 30 participants are commonly used in EEG studies, as they provide sufficient statistical power while maintaining practical feasibility in the collection of neural data (Vecchiato et al. 2011; Babiloni et al. 2010). Therefore, PLS-SEM was selected as the most appropriate technique for this study ensuring robust results.

4. RESULTS AND DISCUSSION

The analysis of the model of destination image formation measured with more objective techniques -EEG- or more subjective techniques -survey and multi-item measurement scale- is presented below.

4.1 Model 1 (see Figure 3): a more objective measure (electroencephalogram) of the image's cognitive and emotional dimensions.

Figure 3
STRUCTURAL MODEL 1



Model 1 was assessed for discriminant validity; this refers to the model's ability to differentiate between the different constructs that make up the model; this assessment is essential to ensure that each construct is being measured appropriately and is not confused with others. Model 1 has been shown to have discriminant validity, meaning that the indicators that have been used to measure each construct have a higher correlation with their construct than with other constructs in the model (see the diagonal in Table 5), indicating that the indicators are effectively measuring the construct with which they were associated and are not being significantly influenced by other constructs (Fornell and Larcker 1981a; 1981b).

Table 5
DISCRIMINANT VALIDITY OF MODEL 1

Factor		F1	F2	F3
F1.	Cognition	0,822	N / A	N / A
F2.	Emotion	0,447	0,820	N / A
F3.	Image	0,742	0,692	0,839

The results also indicate that there is convergent validity in model 1, the average variance extracted for each latent variable in model 1 is greater than 0.5 (see Table 6) (Hair et al. 2012). This measure is used to assess the convergent validity of a model, which implies that the observable variables that make up a latent variable are correlated with each other and that they measure the same underlying construct, since in model 1 the average variance extracted is greater than 0.5, the observables are considered to measure more than half of each latent construct; this indicates that the indicators measuring the underlying construct are adequate and accurate.

Table 6
CONVERGENT VALIDITY. MODEL 1

Factor	Indicator	Charge	Weight	P-value	t-value	AVE*
F1.	α1		0,846	0,000	7,038	0,673
	α2		0,793	0,000	5,401	
F2.	β1		0,871	0,000	10,344	0,676
	β2		0,770	0,002	3,050	
F3.	X_α	0,854		0,000	6,978	0,704
	X_β	0,824		0,000	6,265	

*Average variance extracted

Regarding the 3 first hypotheses, H1a, H2a, and H3a, the results support their testing and are accepted; thus, all beta values are significant at the α=0.05 level (see Table 7).

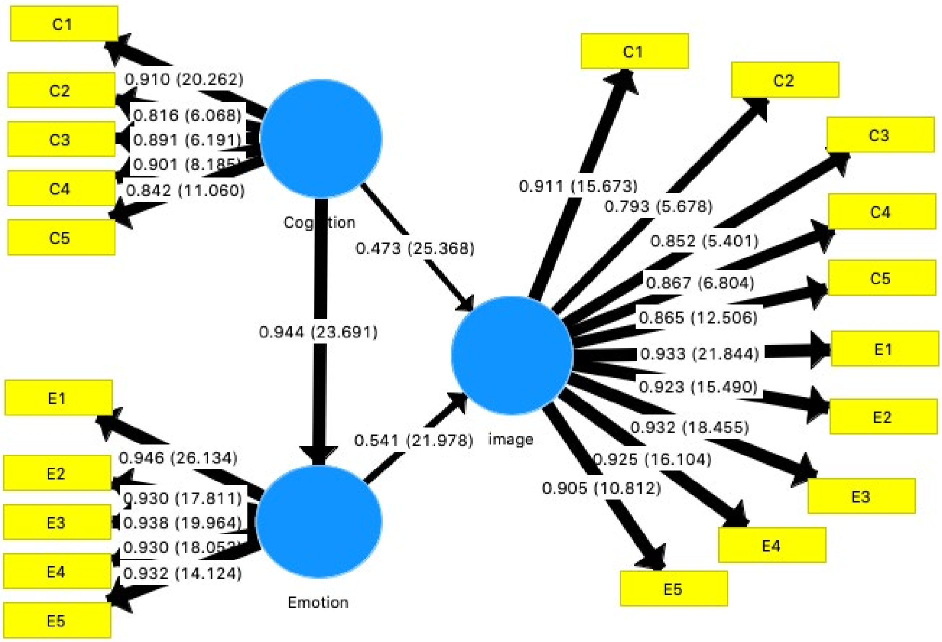
The largest effect is in the relationship between cognitive response and destination image (β=0.541; p<0.004), followed by the emotional response effect on destination image (β=0.450; p<0.026) and finally the cognitive response effect on the emotional response (β=0.447; p<0.006).

Table 7
HYPOTHESIS TESTING. MODEL 1

Hypothesis	Standardized Beta	P-value	t-value
H1a:	0,541	0,006	2,755
H2a:	0,447	0,004	2,887
H3a:	0,450	0,026	2,230

4.2 Model 2 (see Figure 4): a more subjective measure (multi-item measurement scales) of the image's cognitive and emotional dimensions.

Figure 4
STRUCTURAL MODEL 2



Model 2 does not confirm discriminant validity as the correlation between the latent variables themselves is lower than the correlation with the other latent variables (Fornell and Larcker 1981b) (see diagonal in Table 8). A structural equation model may not confirm discriminant validity because the latent constructs that are supposed to be distinct and unrelated to each other are too highly correlated and then it may be difficult for the model to differentiate between them, another possible reason is that the items or variables measuring the latent constructs may be correlated with each other; this may lead to correlations with the wrong constructs in the model, which may make the constructs appear less different.

Table 8
DISCRIMINANT VALIDITY. MODEL 2

Factor		F1	F2	F3
F1.	Cognition	0,873	N / A	N / A
F2.	Emotion	0,944	0,935	N / A
F3.	Image	0,984	0,988	0,892

An additional criterion for assessing discriminant validity is the *heterotrait-monotrait (HTMT*); the criterion indicates that discriminant validity exists when the correlations between constructs are less than 0.70 (Henseler, Ringle, and Sarstedt 2015).

This is a recommendable criterion, especially in the case of small samples, such as the one used in this study; however, this criterion is also not met for some indicators of the model that uses the measurement of cognitive and emotional dimensions with multi-item scales; discriminant validity can also be assessed with a cross-loading analysis.

Since the above criteria are not met in model 2, we also decided to use this analysis; through cross-loading, one can examine the correlation between items and latent constructs and determine whether an item correlates more with its construct than with other constructs; if items have high loadings on their constructs and low cross-loadings on other constructs, the model is considered to have discriminant validity.

Regarding model 2, 8 observable variables in the survey measurement scale meet the discriminant validity criterion by cross-loading analysis: C2, C3, C4, C5, E1, E2, E4, E5 (see Table 9).

Table 9
CROSS-LOADINGS BETWEEN ITEMS OF THE MEASUREMENT SCALE. MODEL 2

Indicator	**Cognition**	**Emotion**	**Image**
C1	0,914	0,878	0,915
C2	0,795	0,723	0,774

Indicator	Cognition	Emotion	Image
C3	0,917	0,779	0,863
C4	0,922	0,777	0,864
C5	0,907	0,819	0,880
E1	0,873	0,942	0,930
E2	0,866	0,923	0,917
E3	0,907	0,919	0,934
E4	0,859	0,925	0,915
E5	0,802	0,936	0,894

However, 2 variables do not meet the criterion, C1, and E3, and consequently, the criterion is not met; possibly, the reason lies in the fact that some indicators correlate with other measures that are known to be independent of the variable they are intended to measure in model 2; this is presumably due to the particularity of the destination image model since the endogenous construct virtual destination image is formed with the same indicators that reflect the latent variables of cognition and emotion.

In contrast, concerning the variables involved in model 1, all the observable indicators in the model measured using EEG meet the discriminant validity criterion (see Table 10).

Table 10
CROSS-LOADINGS BETWEEN EMOTIONAL AND COGNITIVE RESPONSES. MODEL 1

Indicator wave	Image	Emotion	Cognition
Average-α	0,854	0,780	0,502
Average-β	0,824	0,365	0,755
Measurement-α1	0,586	0,846	0,417
Measurement-α2	0,549	0,793	0,309
Measurement-β1	0,664	0,441	0,871
Measurement-β2	0,550	0,276	0,770

However, model 2 does show satisfactory convergent validity (see Table 11). The weights and loadings are significant, and the values of the average variance extracted are clearly above 0.5.

Table 11
CONVERGENT VALIDITY

Factor	Indicator	Charge	Weight	P-value	t-value	AVE*
	E1		0,946	0,000	26,134	
	E2		0,930	0,000	17,811	
F1.	E3		0,938	0,000	19,964	0,874
	E4		0,930	0,000	18,053	
	E5		0,932	0,000	14,124	
	C1		0,910	0,000	20,262	
	C2		0,816	0,000	6,068	
F2.	C3		0,891	0,000	6,191	0,762
	C4		0,901	0,000	8,185	
	C5		0,842	0,000	11,060	
	E1	0,933		0,000	12,048	
	E2	0,923		0,000	21,729	
	E3	0,932		0,000	14,798	
	E4	0,925		0,000	21,181	
	E5	0,905		0,000	14,979	
F3.	C1	0,911		0,000	17,178	0,795
	C2	0,793		0,000	5,234	
	C3	0,852		0,000	4,787	
	C4	0,867		0,000	6,537	
	C5	0,865		0,000	8,093	

*Average variance extracted

Regarding hypotheses H1b, H2b, and H3b, the results again support their test and are accepted (see Table 12); all beta coefficients are significant at the $\alpha=0.001$ level; as for the relationships between the latent variables, these are different from those shown in model 1; thus, the largest effect is seen in the relationship between the cognitive component on the emotional component ($\beta=0.944$; $p<0.001$), followed by the emotional component on the image effect ($\beta=0.541$; $p<0.001$) and the cognitive component on the image ($\beta=0.473$; $p<0.001$); these effects levels are not common in other research. In these, the cognition effect on emotion is significant but not at such a high level; moreover, the cognition effect on the image is usually the most important, higher than the effect of emotion, although the opposite result has also been found (Huete Alcocer and López Ruiz 2020; Huete-Alcocer, López-Ruiz, and Grigorescu 2019)

Table 12
HYPOTHESIS TESTING. MODEL 2

Hypothesis	Standardized Beta	P-value	t-value
H1b:	0,473	0,000	25,368
H2b:	0,944	0,000	23,691
H3b:	0,541	0,000	21,978

The results confirm that both models are probable, as well as all the hypotheses put forward; thus, in the same way as the literature consulted, the analysis shows that the emotional and cognitive impact of a tourist destination, in this case, a cultural heritage destination recreated with virtual reality, positively influences the image of the tourist destination; therefore, the positive emotional and cognitive impact of the perception of heritage on the virtual tourist is confirmed, as was found by Royo-Vela and Garzón-Paredes (2023) when researching real destinations and heritage assets.

Regarding the research question, the statistics, R^2, and Q^2 were also analyzed to contrast the explanatory and predictive quality of both models (see Table 13); a high R^2 - value over 0.75 or close to 1 - indicates a good fit of the model, i.e. that the exogenous or independent variables of the model explain the variation of the dependent or endogenous variable well.

Table 13
EXPLANATORY AND PREDICTIVE CAPACITY OF THE MODELS BASED ON R^2 AND Q^2

Model	**factors**	**R^2**		**Q^2**
		R^2	**Adjusted R^2**	**Q^2**
1	**F1**			
	F2	0,199	0,165	0,109
	F3	0,713	0,687	0,451
2	**F1**			0,768
	F2	0,891	0,887	0,698
	F3	1	1	

Q^2, on the other hand, measures the predictive quality of the model. That is, Q^2 indicates how well the model can predict future values of the dependent variable. Q^2 ranges from -∞ to 1, with 1 being a perfect fit and negative values indicating that the model is worse than a random prediction.

The value of R^2 or the explanatory power of the variability of the dependent variable, Tourist Destination Image, is higher in Model 2 than in Model 1. The Stone-Geisser test values (Q^2) were calculated using the Blindfolding resampling technique (Chernick and Friis 2003; Davison and Hinkley 1997; Hesterberg 2015) and indicate that the model that best explains image formation is model 2, which uses a more subjective measure of individuals' responses to a set of items based on their memory with a measurement scale. However, these results must be understood with great caution given the lack of discriminant validity detected in the analysis of model 2. Thus, as we are measuring the image with the same items as the cognitive and emotional dimensions of the image, the explanatory capacity of model 2 measured with R^2 is equal to unity, which is debatable due to the procedure used.

Moreover, the value of R^2= 0.891 between the cognitive and emotional dimensions of model 2 shows that these two dimensions are highly correlated and that the emotional dimension is strongly dependent on the cognitive dimension. This is not the case in model 1, which has an R^2 = 0.713 where the measure of the cognitive and emotional dimensions of the destination image do not coincide with the measures used to measure the cognitive and emotional response to the image. In model 1, the cognitive response does explain less than 20% of the emotional response, which, in contrast to the more subjective measures, shows a greater independence or lesser sequencing between the destination image cognitive and emotional dimensions; at this point it is interesting to refer to the traditionally accepted relationship between cognition and emotion, indeed sequential or hierarchical, i.e., that emotions are formed from cognitions (Russell 1980; Beerli and Martín 2004; San Martín and Rodríguez del Bosque 2008). However, this belief in the sequential or hierarchical formation of emotions from cognitions has been discredited or refuted in psychology (Zajonc 1980) neuroscience (Ledoux 1989) or marketing communication (Vakratsas and Ambler 1999; Ambler and Burne 1999). The explanatory power of cognitions on emotions in model 1 does not support this appraisal approach.

5. CONCLUSIONS

The research on Tourist Destination Image (TDI), utilizing both objective and subjective measures along with virtual reality, structural analysis, and neuroscience, has produced innovative and significant findings; this study investigates cultural destinations with heritage elements and demonstrates that heritage stimuli, even when experienced virtually, positively impact the formation of the Tourist Destination Image; historical and architectural heritage enhances both cognitive and emotional responses, which in turn improves the destination's image and attractiveness to potential tourists.

Electroencephalography (EEG) has provided valuable insights into participants' emotional and cognitive responses to the perceived destination; the EEG results reveal a robust positive response in brain activity associated with emotion and cognition; regarding the image formation models tested, while all proposed hypotheses were evaluated, notable differences emerged between the measurement techniques.

In both models, the cognitive dimension directly influences the destination image and the emotional dimension; the emotional dimension, in turn, affects the destination image; however, the strength and nature of these effects vary between models.

Model 2 shows that the effect of cognition on emotion is the strongest, whereas Model 1 demonstrates that the cognition effect is more substantial and direct on the image compared to the emotional one; this finding aligns with previous literature, which often emphasizes cognition's predominant role in shaping the destination image; notably,

Model 1 provides a more nuanced explanation of the relationship between cognitive and emotional responses, whereas Model 2 faces challenges with discriminant validity due to high correlations between cognitions and emotions; our study affirms that measuring the impact of cultural and architectural heritage through virtual reality is feasible and effective using both objective measures; bioelectrical brain waves via EEG; and more traditional subjective measures; responses to survey scales; both approaches reveal a positive impact of cognitive and emotional dimensions on the destination image formation.

The findings underscore the value of both objective and subjective methods in evaluating the Tourist Destination Image, highlighting the necessity of addressing current methodological limitations to achieve a more precise and comprehensive understanding; additionally, the results reinforce the critical role of cultural heritage in shaping destination image and suggest promising avenues for future research, particularly in integrating emerging technologies into TDI studies.

A potential area for improvement in future studies is the diversification of the participant sample; while the detailed demographic information provided; including residence, gender, age range, educational level, and familiarity with the destinations; is valuable, the sample is homogenous in terms of being exclusively from Latin America, possessing a university education, and lacking prior familiarity with the destinations presented; this homogeneity may limit the generalizability of the findings to broader populations with varying demographic characteristics or cultural contexts; therefore, future research could benefit from incorporating a more diverse sample in terms of geographical region, educational background, and other heritage assets to gain a more comprehensive understanding of emotional and cognitive responses to tourism stimuli.

In addition to this, it is important to note that the study faced limitations in the convergent validity of the factors in Model 2. Moreover, the EEG data collection tool used in the study can be further enhanced; utilizing state-of-the-art EEG equipment could allow for the more precise data collection on brain responses to virtual reality stimuli; with such advanced equipment, it would be possible to accurately detect and analyze the synchronization of EEG with virtual reality, determine specific points in the video clip where stimuli are heightened, and identify the areas of the brain activated; this optimization would enable the real-time establishment of sequences or correlations between cognition and emotion, or parallel responses, and provide insights into which stimuli or heritage assets have the most significant impact on visitors' cognitions and emotions.

Therefore, a potential future research direction involves designing and studying virtual reality video clips for more specific communication and stimulation purposes; this would allow researchers to pinpoint the exact moments in the video when a greater stimulus is produced and identify which specific brain areas are activated in response; another valuable line of inquiry would be determining whether the emotional response precedes, follows, or occurs simultaneously with the cognitive response; this could be analyzed by comparing EEG timelines with the projection time of the virtual reality video; in doing so, the alpha and beta waves generated when the subject searches for something specific in VR could be further explored; this would enable a deeper investigation into Russell's emotional space, seeking potential correlations with bioelectrical brain waves triggered by visual stimuli, as recorded in the EEG and VR projection timelines; ultimately, these research paths could provide valuable insights for the design and development of more effective and meaningful virtual reality experiences.

Lastly, another interesting research direction could focus on identifying differences in the intensity of cognitive and emotional responses between various types or styles of heritage architecture.

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