

POV 3

POV 2

POV 1

Cross-cultural aspects of streetscape perception

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Abstract: Public space auditing is an efficient tool for urban planning of active mobility infrastructures. It enables real estate developers and urban planners to judge the level of comfort their design of sidewalks and public places can provide. Most of the research focus on the methodology to characterize the satisfaction of a public space, but there is a lack of knowledge about inter-cultural aspects of such methods. Our main research question is whether there is consistency in the way in which French and Spanish auditors perceived an urban streetscape: would they rate a public space the same and what features would be differently audited. We selected three urban identities of a modern district representing a variety of urban form: a public place with a tramway station, a commercial street designed as a strip mall, and green residential area with leisure activities. Each of these points of view were audited by a pool of French and Spanish participants according to criteria related to buildings' architecture and sidewalks' design for walkability and cyclability purposes. Both virtual reality and real scenes of the public spaces were recorded in videos and provided to participants for rating purposes. Architectural ambiances were measured with qualitative scales, quality of public space was measured with two integrated indicators of pedestrian level of service, and the accordance of infrastructures for active mobility was probed with individual scales. Results from the audit suggest that some streetscape impressions may be quite similar when assessed with various types of measurement, in different cultural contexts: scale, size and architectural style stimulate the same kind of feelings, and the quality of public spaces were perceived equivalently by the two communities as well as bikeability. Dissimilarities in perception occurred for the perception of materials and general feelings of the areas, and in the rating of walkability and in preferences for walking.

Keywords: Architecture; Sidewalk; Walkability; Cyclability; Cross-culture; Urban forms.

1. Introduction

Streetscape refers specifically to the visual appearance and overall character of a public space, including elements such as buildings, sidewalks, street furniture, landscaping, and other features that contribute to the aesthetic and functional experience of being in that space. Streetscape often focuses on the design and arrangement of these elements within the street or public area and how they interact to create a sense of place and identity. Buildings constitute the vertical environment of streetscape and are fundamental elements of it. An exploration into architectural ambiances can pinpoint the features that evoke particular emotions associated with a specific atmosphere. These features are quantifiable, enabling the formulation of guidelines to craft scenes with architectural atmospheres that reflect an architect's intended vision. Deeper insights into these identified characteristics can yield benefits on social and commercial fronts, enhancing public environments and living spaces. Sidewalks are the horizontal built environment of streetscape: they also spark feelings related to the quality of public spaces.

When auditing a public space, a sidewalk or a public place, architectural ambiance and sidewalk characterization are complimentary. Yet the result of a public space auditing performed by human participants could be dependent on the shared culture of the corpus of participants. This is what we will try to investigate in this study by comparing the sensations of Spanish and French participants raised by auditing the same urban places with the same media: videos of real and simulated environment. Therefore, the literature provided hereafter is twofold: a first part is dedicated to technics for public space auditing, and a second part deals with the previous works related to cross-cultural aspects of characterizing an outdoor urban place.

1.1 Perception of streetscape

There are at least two fundamental elements of the streetscape that need to be accounted for when auditing a public space: the buildings and the streets including urban furniture and vegetation. Those two aspects are usually studied separately although buildings are implicitly considered when auditing the quality of sidewalks and public places.

Most of the research in this field relies on subjective measures to grasp individuals' perceptions of walkability within neighborhoods. Generally, these approaches consider a range of factors related to the streetscape, which help classify specific road sections

or areas as safe and comfortable for walking or cycling, often expressed through a numerical rating. When evaluating walking, this assessment is commonly known as "walkability," while terms like "bikeability" or "cyclability" are utilized in literature concerning cycling suitability.

In the book of Ewing et al. (2013) the challenging dimension of street design/landscape in walkability assessment is addressed. The study proposes protocol to measure features like imaginability, visual enclosure, human scale, transparency, and complexity. It provides methods to assess urban design through field surveys experimentations.

One prevalent method for assessing pedestrian comfort and safety is the Pedestrian Level of Service (PLOS), adapted from the Highway Capacity Manual. Jaskiewicz (2000) proposed walkability indicators such as the complexity of spaces and paths, separation between pedestrians and traffic, and the presence of shade and overhangs. In this article, we refer to his method, known as the PLOS Trip Quality Method, as a benchmark, although other PLOS algorithms are available in the literature.

Existing tools for auditing public spaces usually requires time-consuming onsite interviews, surveys (Wei, 2021), focus group and document analysis (Wang & Foley, 2021), which are labour-intensive. The use of images is common in aesthetic assessment of buildings and streetscape (Coburn et al., 2017) and it is a low-cost method to qualify a built environment. Street view imagery exploitation is an example of ease of use, and time saving way to assess the quality of a streetscape. It is an important data source for urban analytics: Biljecki and Ito (2021) did a systematic review of the state of the art of how street-level imagery is currently used in studies related to the built environment. The main findings are that: street view imagery is now a solid component of urban analytics with most of the research relies on data from Google Street View. It is used across domains with numerous applications from analysing vegetation and transportation to health and socio-economic studies. The still images can be processed by a machine learning algorithm (Liang et al., 2023) or by human participants (Lu et al., 2019).

Kim and Li (2022), and Mouratidis and Hassan (2020) based their respective work on recorded virtual environments with 360 panoramic videos: participants follow a predefined guided tour in a Head Mounted Display (HMD). The larger the size of the study area, the greater the advantage of VR audit. But the use of HMD makes it hard to investigate a large corpus of

participants: 10-person expert panel participated in all three steps of the streetscape audit in Kim and Li (2022). All experts hold doctoral degrees in urban design or transportation planning. 28 students participated to the auditing of four streets and four public places in Mouratidis and Hassan (2020). Gomez-Tone et al. (2021) recruited 22 students and 7 experts for a study of ephemeral architecture based on an HMD experimental setup.

Less immersive virtual environment than Head Mounted Device (HMD) can be used such as the study conducted by Kuliga (2015): the walkthrough virtual model is implemented with a desktop screen with a video showing a long route inside a building. Participants are engaged in a guided walk through the building, in an indoor-only visit. The virtual presentation used predefined, directly connected building routes that covered most of the building. Participants rated the environment with a custom-made questionnaire for environmental appraisal. Our experimental protocol also uses videos of guided tours of the virtual and real outdoor environment.

Such a video-based protocol with guided tour was successfully implemented by Belaroussi et al (2023): urban planning solutions were proposed to make the Canal Port of Rimini a continuum with its urban context and to improve its perception by tourists and inhabitants. To assess these proposed infrastructure modifications, two models of VR were created, one relevant to the current condition and one representing the future condition after redevelopment of the area. Participants were asked to audit the quality of the public space in both scenarios.

1.2 Cross-cultural aspects

Environmental factors such as infrastructure, land use, aesthetics, traffic volume, pedestrians and other cyclists on road, and sociodemographic factors are often cited in the literature as crucial determinants of walking or cycling experience. Very few moderating parameters were explored with relation to perceived sensations of a built environment except from using a balanced sample of age/gender. One such parameter is culture. The limited number of studies that have attempted cross-cultural exploration encountered challenges with the blending of place and culture, given that respondents reside in diverse countries. To address this issue, pictures or videos were utilized instead of actual locations.

For example, Calvillo Cortés and Falcón Morales (2016) described significant differences in public space lighting-induced emotional reactions between participants from European-based cultures and participants from Mexico when exposed to still pictures of urban spaces. They used pictures of parks, gardens, squares, and pedestrian areas to test the emotions brought by different conditions of lighting. Participants were university student from Mexico (n=103), France (n=59) and Spain (n=55). They found that inspired emotions of uncertainty, fear, affection, fascination, and entertainment are consistent across culture when surprise, inspiration, contempt, and disappointment are sensitive to culture.

Van de Berg et al. (2022) investigated differences in park preferences between Dutch and Chinese park users. They collected data in the Netherlands (n=540) and China (n=719) using an online stated choice experiment with videos of virtual parks. Beside a common preference for parks with many trees, they identified differences in preferences for park attributes related to vegetation (composition of trees and flowers), the presence of benches and play facilities. They explained them by differences in park use, values of nature, and landscape preferences. Yu (1995) had previously underlined that living environment (urban vs. rural) is a powerful predictor of variance in parks landscape preference in a study comparing responses from 24 design graduate Western students against Chinese subjects by rating 50 scenes (color slides) from a Chinese national park, on a 1-10 points scale. Ordóñez-Barona (2017) evaluated in a literature review the empirical evidence on the importance and meaning that ethno-culturally diverse people associate with urban nature, for those interested in this topic.

Marković et al. (2016) compared the answers of 21 Serbian and 20 Japanese participants in their subjective experience of Serbian and Japanese architectural objects. A set of twelve photographs of elements of outdoor architecture were displayed from each country, and rated on criteria such as beauty, firmness, and fullness.

Ruggieri et al. (2017) compared interpretations of livability between 53 Americans and 19 Norwegians graduate students in landscape architecture and planning, involving both in-person and Google Street View audits performed in San Francisco (CA) and Oslo (Norway) neighborhoods. Audits recorded measurements of walkability, compactness, connectivity, enclosure, and imageability.

1.3 Research purpose

The sceneries of this study incorporate dynamic elements representing various urban environments: a public area with a tramway station, a commercial street with a road and a residential playground with green spaces. The three urban identities were used as an element of comparison about the satisfaction expressed by French and Spanish participants. Two main questions of research are investigated:

- Are there differences in the perception of buildings and architecture across culture?
- Is the assessment of sidewalk and public places consistent across culture, and what are the common element of auditing?

Virtual environment and real built environment of a modern district are used as a media for rating the proposed streetscapes, as this study started before the construction of the real estate and ended with the installation of inhabitant in the residential area.

2. Material and Methods

2.1 Case study

We investigate the public spaces of a newly formed district 7km from the south of Paris France called LaVallée. It is a real estate project of 20 hectares still under construction although the first phase of the project is completed as of 2024. Figure 1 gives the layout of the district seen from above: blue polygons represent the footprints of the future buildings, while some parts have been built. Working with the real estate developers we were given access to the Building Information Model (BIM) files of the planned construction. From them we were able to build a 3D city model described in a recent paper (Issa & Belaroussi, 2024). Our study started before the completion of the first phase of the project and uses this virtual environment for the architectural auditing part. The quality of public spaces was then audited later after the real built environment was set up and uses real videos of the current district.

This territory of experimentation encompasses three point of view (POV) that were retained for this study. They represent three urban identities often present in modern urban development. The first POV is a central place used as an entry point in the south of the district: it is a public plaza with a tramway station. This area encompasses a large complex of office space, seamlessly integrated into the neighbourhood,

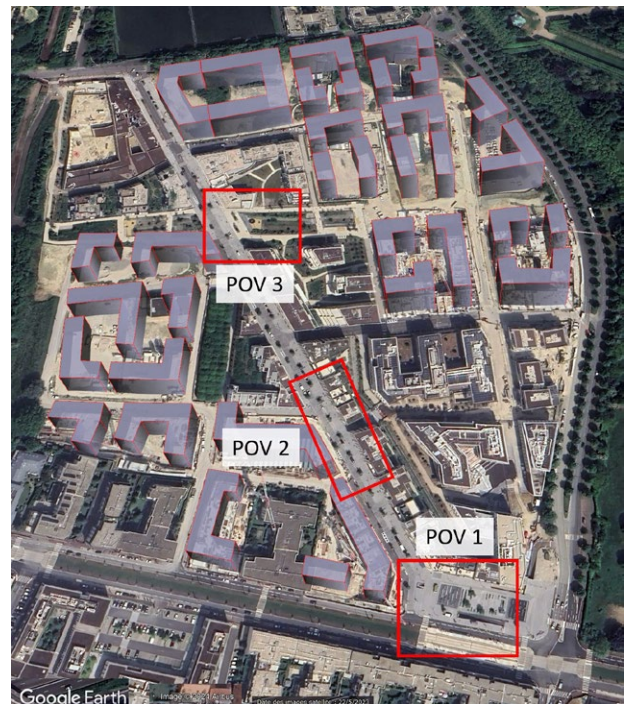


Figure 1 | Overview of the district of experimentation.

ensuring a vibrant atmosphere throughout the day. Access to this part of the district is limited to pedestrians and start from the Tramway stop.

“Living in the course of stores” identity is constituted by POV 2: it is the main drag of LaVallée. It is a commercial street with shopping activities and a central road running from the south to the north of the district. The use of modest materials and colours lends an elegant character to the shopping street. The ground floor houses the shops, while residential units are located on the upper floors.

The last identity is POV 3 and is called “Living on the planted promenade”. it is a green residential area with a pedestrian walkway running across from East to West with a central garden and a children playground. This promenade serves as an urban park, offering residents a peaceful retreat.

The three POV were captured both in virtual reality (VR) and in real, on videos of 1 minutes long. These videos were displayed online to human participants: a one-minute guided tour takes participants on a journey through the POV before asking them to complete a questionnaire after each show using a Google form.



Figure 2 | The three selected point of view.

2.2 Methodology

Two aspects of public space auditing were investigated in this study: architectural ambiances of buildings and quality of public spaces focusing mainly on sidewalks and their walkability. Human participants to this study were recruited online and are from various background: students, researchers and professors from University Gustave Eiffel in France and University de La Laguna in Spain.

The architectural characterization experimentation started at a time when the buildings were not completed and was done using a virtual environment. This VR setup was validated by participants and deemed of a

fine enough visual quality to forego an aesthetic analysis of the district: see Issa & Belaroussi (2024), for more information on the photorealism of the 3D city model.

There are many ways to characterize an urban space: it can be simple adjectives such as terrible architecture/excellent architecture, it can be spatial quality factors such as enclosure/ human-scale/transparency/tidiness/imageability, or a scale for attributes such as Preference/ Complexity/Impressiveness, or material/color/ ornament/vegetation/windows/architectural style, or aesthetic/ organization/friendliness, or the characterization of intrinsic aspects/extrinsic aspects, or choosing between calm/pleasant/ safe/interesting. We used the protocol proposed by Gomez-Tone et al.

(2021), which focuses on the perception of spaces based on 3D sketches of ephemeral architectural elements. Participants are asked to imagine visiting the depicted using 3D modelling techniques and answer a series of seven questions. In our study, these questions were applied to a 3D city model created from professional BIM data.

Participants are encouraged to reflect on their feelings and evaluate the public nature of the urban space, the intended usage of the public space, and their impressions of size, materials, enclosure, and architectural style during the virtual tour.

The second aspect of this study is more horizontal: the sidewalk and the satisfaction brought by its design. This satisfaction was measured through the use of indicators. Due to our focus being primarily on the pedestrian experience in public spaces, the indicators chosen assess the overall pedestrian experience within these areas based on real videos scenes.

A first set of indicators chosen for the assessment were an adaptation of the Pedestrian Level of Service - Trip Quality Method (PLOS-TQM) proposed by Jaskiewicz (2000) and the Sustainable Urban Mobility Indicator for

Quality of Public Space (SUMI-QPS) described in the report of Ruprecht Consult and al. (2020).

Those are two integrated indicators as they provide a single value that is a weighted average over different criteria and over all participants' ratings. The second set of indicators are related to independent measurement of the walkability and bikeability of the street, by prompting participants to rate these criteria according to their sentiment.

All the indicators were computed by displaying participants one-minute videos of the real built environment of the three urban identities as illustrated by Figure 2.

The PLOS-TQM integrates notions relative to the complexity of the path network, the complexity of the place, the presence of buffer area and the shades from trees.

The following questions were asked to participants for each of the POV:

- How simple is it to understand the pedestrian path network in the area?

- How simple is it to understand the function of the surrounding public spaces in the area?
- Rate the availability of buffer areas for pedestrians to wait or conversate in the space.
- Rate the sufficiency of shade and shelter provided along the area.

Participants were asked to rate these aspects on a scale from 1 for "Very poor" to 5 for "Excellent". PLOS-TQM is then the average score over all participant and over the four characteristics, giving a single score on a 1-5 scale: the greater the score the better the quality of the space.

SUMI indicators are used to offer technical assistance on assessing urban areas and their urban mobility. The indicators are endorsed and used by the European commission and are developed based on the "SMP2.0 Sustainable Mobility Indicators" developed by the World Business Council for Sustainable Development. They also aid cities in tracking the impact of their policies through a widely accepted and harmonized approach. We selected the SUMI-QPS as it was the more adapted to our experimentation based on human sensation of places, parks, and sidewalks. The indicator is an averaged score of survey responses about the perception of satisfaction with public and green spaces. To calculate the SUMI-QPS, two questions are asked: "Rate your overall satisfaction with the public spaces available in the area presented" and "Rate your overall satisfaction with the green spaces available in the area presented": those are the two aspects considered. For each of the two questions, the participant had to provide a ranking between 1 and 4 for each option (satisfied, rather satisfied, rather unsatisfied, not at all satisfied): this constitutes the agreement scale. Each possibility is given a fractional weight of ten. The formulation used to compute the indicator from the aforementioned input is the following:

$$\overline{SUMI - QPS} = \frac{\sum_m \overline{ASPECT}_m}{m},$$

$m = \text{the number of aspects}$

$\text{aspects} = \{\text{public space; green space}\}$

$$\overline{ASPECT}_m = \sum_h \frac{\text{number of agreement } h \text{ for aspect } m}{\text{number of respondents for aspect } m} \times 10 C_h$$

with

$h = \text{strongly agree, } C_h = 1;$

$h = \text{somewhat agree, } C_h = 2/3;$

h = somewhat disagree, $C_h = 1/3$;
h = strongly disagree, $C_h = 0$

Based on the answers of participants, two weighted averages are computed, one for the public space satisfaction and the other for the green space satisfaction, and the average of the two is taken to obtain the final SUMI quality of public space indicator.

Finally, to characterize awe also used single independent indicators that directly rate the walkability and cyclability of the built environment. Walkability was defined as the extent to which the built environment supports and encourages walking as a means of transport by providing for pedestrian comfort and safety. Bikeability was defined as the extent to which it is convenient and safe to use biking as a means of transport in an area. The scale of answers proposed ranged from 1 for “Not walkable” or “Not bikeable” to 5 for “Highly walkable” or “Highly bikeable”. We also asked the participants their overall impression of the POVs, and if they would be willing to walk or to cycle to move around the areas. The perceived walkability and bikeability for the three POV were compared between the French and Spanish community using boxplots giving the distribution of answers and were analysed by ANOVA test to measure how different the mean satisfaction was indexed.

3. Experimental Results

3.1 Corpus of participants

Participants to this study were recruited online and are from various background, about two third graduate students, and one third researchers or professors from University Gustave Eiffel in France (Uni Eiffel) and University de La Laguna in Spain (ULL).

Two experiments were conducted at different time for the purpose of this investigation. Table 1 recaps the main features of those experiments: number of participants, media used for auditing purpose and focus of the study.

The first experimentation focused on architectural ambiances. It was conducted at a time when the buildings were still under construction and so it was based on 1-minute video of tours of virtual environment of the three urban identities. It used a 3D city model of the future real estate. Among the university communities a quarter of the respondents are in the area of expertise related to this study: students and teachers in architecture, urbanism, or civil engineering. The remaining

Table 1 | Main characteristic of the two studies.

	Experiment 1	Experiment 2
Focus	Architecture	Sidewalk
Media	Virtual video	Real video
# French	n=53	n=55
# Spanish	n=66	n=68
Total	N=119	N=123

75% of the participants have more general background and no expertise in the area of architectural ambiance. A total of 119 participants were included in this first experience with the only inclusion criteria being to be an adult: 53 of them from the French University and 66 from the Spanish University. The participants were equally balanced in terms of gender, half male, half female. The 50% are under 26, the 30% are aged between 26 and 50 years-old, and the rest 20% are more than 50 years-old.

The second experimentation focused on the sidewalk auditing. The same online recruitment was performed: the voluntary participants consist of adults from Uni Eiffel and ULL, not involved in the LaVallée real estate. The questionnaire consists of three identical parts, one for each POV, each featuring a 1-minute video of the real scene acquired on-site. A total of 123 people answered, where 55 participants were French, while 68 were Spanish, so approximately the same number of participants that the first study. In this second experience, the gender distribution was 50/50 for the French group, while the Spanish participants were 43% male versus 57% female. Besides, this corpus is globally younger than the first study with 60% of participants under 26, 30% are aged between 26 and 50 years-old, and 10% are more than 50 years-old.

3.2 Architectural ambiances

3.2.1 Scale and Size

Three characterizations were proposed to quantify the scale and size aspects of the virtual tours: Grandeur, Balance and Restlessness. Figure 3(a) illustrates the results obtained from the French (Fr) and Spanish (Sp) participants, showing a lot of similarities. The question asked was “Scale and Size: what feeling do you feel the most?”. For each POV only one response was possible.

The most expressed feeling by both French and Spanish participants was Balance: from 60% in POV1 to 75% in POV2 of French raters, and from 55% to 67% for their Spanish counterparts for the same POVs. Restlessness came second in 15% to 26% of French

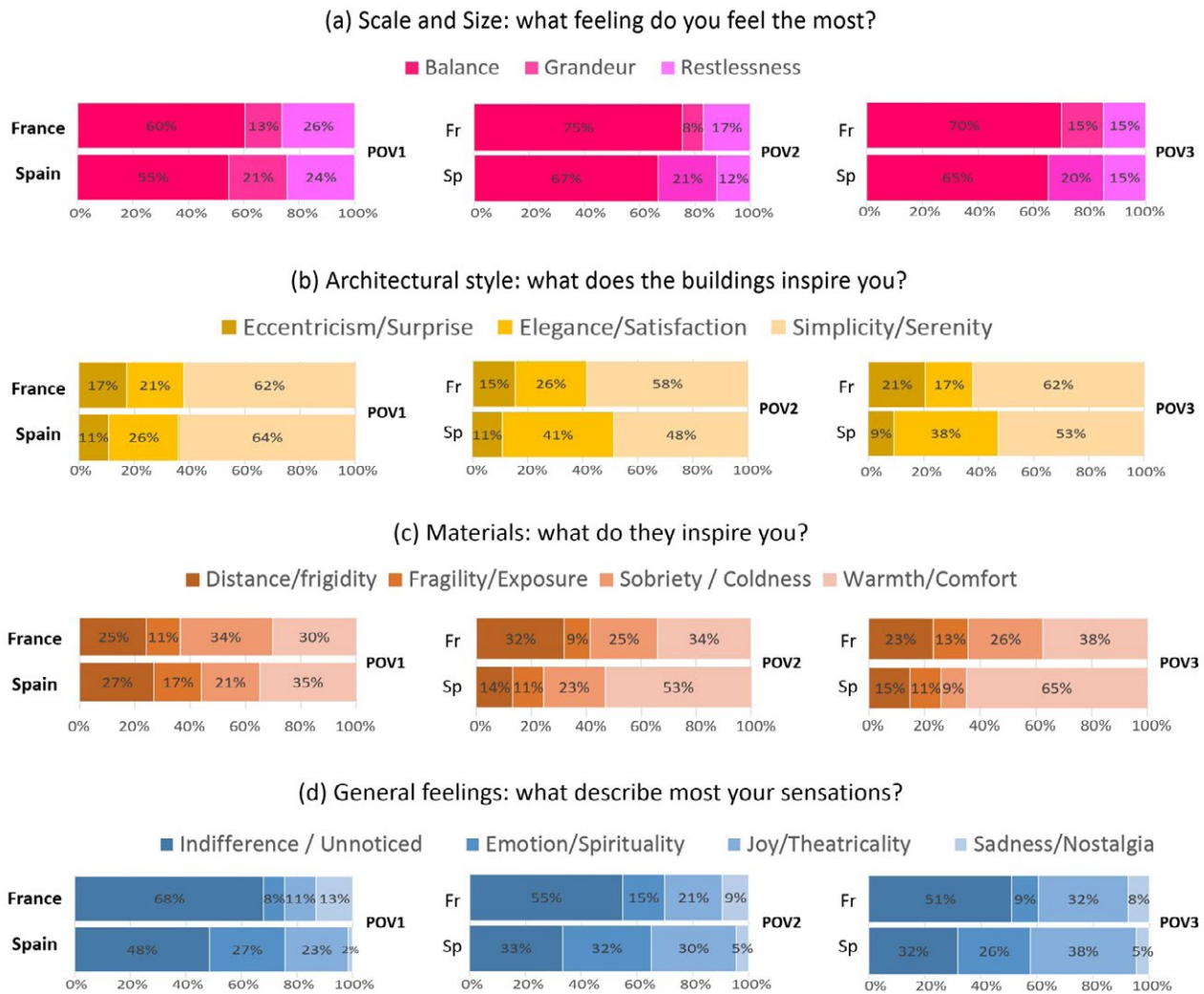


Figure 3 | Architectural ambiances: France-Spain comparison of three urban identities' POV.

raters, while Grandeur came second with approximately 20% of Spanish opinion pool. The larger gap between expressed opinion is in POV2 with a difference of 13% between Grandeur sensation chosen by 8% of French against 21% of Spanish. Except for this slight difference, the results auditing of Scale and Size aspect are coarsely the same in both cultures.

3.2.2 Architectural Style

Architectural style can be audited with three criteria: An Eccentric style that sparks Surprise, the sensation of Elegance bringing Satisfaction, a feeling of more

Simplicity with a concomitant Serenity. Public opinion was canvassed based on these three qualifiers, with only one possible choice among them.

In Figure 3(b), the three urban identities selected from LaVallée district stimulated two kinds of reaction among the public audience. The three POV, either the public place, the shopping street or the residential area sparked a more general feeling of Simplicity and Serenity in 58% to 62% of the French participants. The Spanish mostly agreed on this qualification with the slight variation that on POV2 and POV3 Simplicity/Serenity is still the most tallied qualifier but with only

48% to 53%. For these two POV, Elegance/Satisfaction gather around 40% of Spanish participants' votes, with only 26% and 17% from French participants.

Eccentricism and Surprise is less popular in the Spanish pool than in the French one, whatever the type of urban identity, but in a limited proportion however: the opinion on architectural style can be judge as coarsely the same across French and Spanish culture. The larger difference is on POV3 with 38% of Spanish choosing Elegance/Satisfaction against 17% for French: larger gaps of perception are found on the "Materials" feature.

3.2.3 Materials

Figure 3(c) shows the impressions stemming from materials used in the POVs imagery. Four set of characterizations was proposed: Distance / fridity, Fragility / exposure, Sobriety / coldness, and Warmth / comfort.

POV1 was rated approximately the same by French and Spanish, except a little less 21% of Spanish voting for Sobriety/coldness against 34% for French. POV2 and POV3 were rated very differently by the two communities.

For instance, POV2 was felt as Warmth by half of the Spanish corpus and a quarter of them voted for Sobriety. The feeling amongst French for this POV was more balanced between the adjectives Distance, Warmth and Sobriety. The difference of judgement was even greater in POV3: a large majority of Spanish deemed it as Warmth and comfortable, while French group was less categorical. Only 40% of them felt it as a warmth streetscape, most of the remaining voters being distributed between distance (23%) or sobriety (26%) sentiments.

3.2.4 General scene sensation

Participants were asked a more general question about the ambiance felt during the virtual tours.

The question asked was: "What kind of feeling describe most your sensation inside the scene?" A set of four emotions was proposed: Indifference, Emotion / Spirituality, Joy / Theatricality, and Sadness / Nostalgia.

In dark blue in Figure 3(d) are the votes tallied for the Indifference emotion: in all part of the district, it is the most expressed feeling, especially in the central plaza where this feeling was shared by 68% of the French participants, and 48% of the Spanish. This overwhelming share of the Indifference emotion can be explained by a lack of definition of what an architectural

PLOS trip quality model

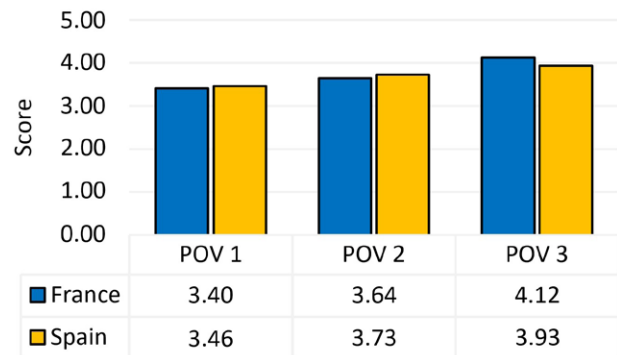


Figure 4 | Average scores for PLOS trip quality model for the three POVs.

ambiance is. The participants have difficulty choosing between the different proposition because they simply might not fit their experience during the guided tour. However Spanish people seems to struggle less with this notion in POV2 and POV3 for which only a third of them expressed Indifference at the scenery, the rest of their vote being parted between Emotion/Spirituality and Joy / Theatricality. One possible explanation is that Spanish is more inclined to give a more precise sensation than just indifference. Another possible explanation would be that the Spanish were more enthusiastic about the VR experiment while it made less sense amongst French participants.

Joy / Theatricality was the second choice amongst the French participants, while the second choice for Spanish was Emotion / Spirituality and Joy / Theatricality in POV1 and POV2. Sadness / Nostalgia was a minority feeling in all the guided tours, according to all participants.

3.3 Quality of public spaces

The quality of public space was measured according to two integrated indicators that sums up various aspects of public space auditing: PLOS-TQM and SUMI-QPS.

3.3.1 Pedestrian Level of Service: Trip Quality Model

Four factors were considered in computing the PLOS trip quality model, i.e., clarity in pedestrian path network and the function surrounding the public spaces, the availability of buffer areas, i.e., area where people can stop to rest without interrupting traffic flow, and the sufficiency of shade and vegetation. Figure 4 shows the average scores for PLOS for each POV and

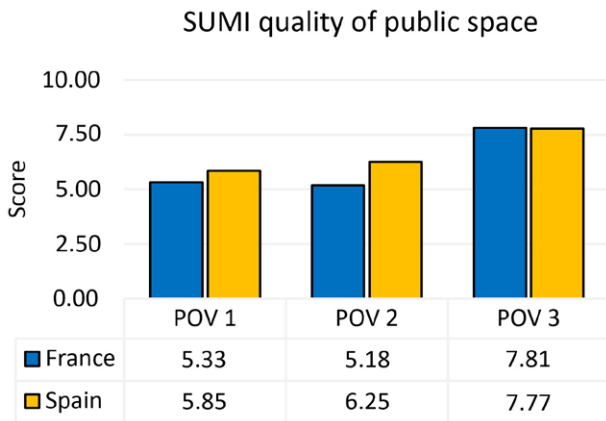


Figure 5 | SUMI scores for the three POVs.

cultural group. For both respondent groups, POV 3 has the highest average PLOS score, followed by POV 2 and POV 1, respectively.

POV 3 offers the best streetscape elements than other POVs. This green area allows people to walk safely and comfortably due to clear pedestrian path network, and the presence of benches, garden, and play area encourage people to conduct activities outdoor without interrupting pedestrian flow. Attractive street-scape and the presence of street furniture can increase activities in public spaces (Jing, 2022). As shown in Figure 2, POV 2 provides road segregation that ensures safety and comfortability of pedestrians. Although it is one of factors considered in PLOS assessment, the lower score compared to POV 3 suggests that visual attractiveness and street furniture may have more significant contribution in increasing PLOS.

The repeated measures ANOVA were performed to know whether there is a significant difference in the average PLOS scores of the three POVs for each respondent group. It is found that the results are significant for both respondents from France ($F(2, 108) = 30.97, p < 0.05$) and Spain ($F(2, 134) = 15.42, p < 0.05$). The pairwise comparison tests at the confidence level of 95% show that for both groups, POV 3 has the highest PLOS scores statistically than the other POVs. Compared to POV 1, POV 2 has statistically higher PLOS scores. Further, the independent sample t-tests show that the difference in the PLOS average scores between respondents from France and Spain for all POVs is not statistically significant.

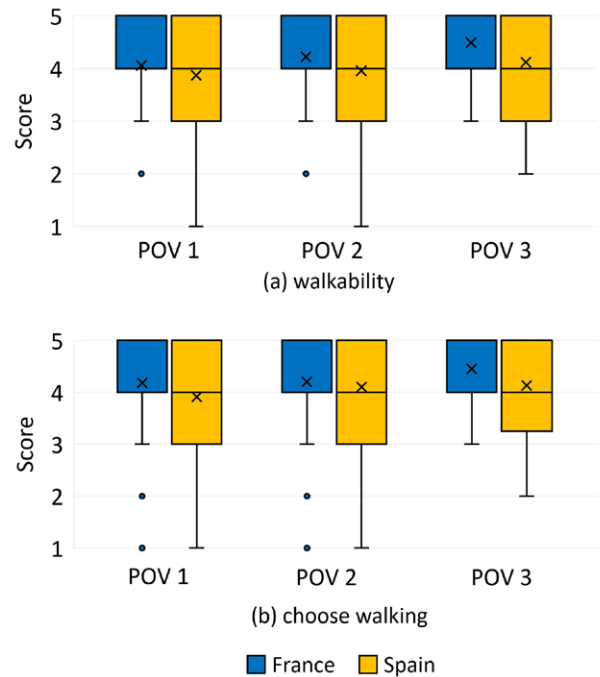


Figure 6 | Comparison of average scores of the three POVs regarding a) walkability and b) choose walking.

3.3.2 SUMI Quality of Public Space

SUMI scores were calculated in this study to represent the average of public space and green space satisfactions.

Figure 5 show SUMI scores based on a weighted average. The scores for POV 3 are the highest for both respondent groups, confirming the importance of vegetation in urban space.

The role of vegetation in streetscape is crucial since it increases urban area attractiveness, comfortability through shades, and perceived safety (Ferrer et al., 2015; Huang et al., 2023; Wang et al., 2023). Further, Huang et al. (2023) suggest that trees have a better effect in increasing streetscape attractiveness than smaller size vegetation, e.g., shrubs, due to the ability to provide shades. This might contribute to the low scores for POV 1 across all assessments, considering that shrubs are dominantly presented in this area compared to trees.

The score for POV 1 is higher than POV 2 for respondents from France. Meanwhile, the score for POV 1 is lower than POV 2 for respondents from Spain. When scores from both groups are compared, respondents from Spain gave higher SUMI scores than France. But

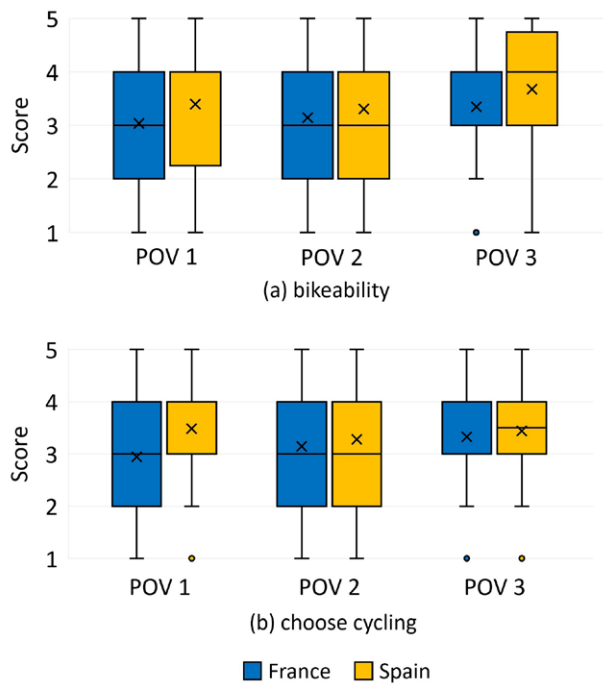


Figure 7 | Comparison of average scores of the three POVs regarding a) bikeability and b) choose cycling.

the difference is not very large although more important than with the PLOS-TQM. But coarsely it can be said that the satisfaction expressed by this indicator would be sensitively the same across French and Spanish culture.

3.4 Active mobility

In this research, respondents were asked to evaluate the walkability and bikeability of each POV on a 5-point scale, with 1 for “Not walkable” or “Not bikeable” and 5 for “Highly walkable” or “Highly bikeable”. The propensity to choose walking or cycling as a mean of transportation in the area was also investigated. A Likert scale was used from (1) for Unlikely to (5) for Very likely.

Figure 6 presents the results on walkability and choosing walking, while Figure 7 presents the result on bikeability and choosing cycling. Coarsely, it appears that walking aspects show the most significant differences across culture.

Almost all French participants found the areas highly walkable and would choose to walk with ranking between 4 and 5, while the Spanish were less categorical with a ranking spread between 3 and 5 for the aspects related to walking. Responses to cycling aspects were somehow similar across cultures.

Repeated measures ANOVA tests were performed to know whether different POVs result in different scores on active mobility items for each group. For respondents from France, there is a significant difference in scores for walkability ($F(2, 108) = 7.60, p < 0.05$), choosing walking ($F(2, 108) = 1.28, p < 0.05$), and choosing cycling ($F(2, 108) = 3.32, p < 0.05$). The pairwise comparison tests indicated that the average scores for POV 3 (4.49) are significantly higher than POV 1 (4.05) and POV 2 (4.22) for walkability. While there is no statistical difference for the scores between POV 1 and POV 2, the latter scores higher than the former.

For both choosing cycling and walking, it is found that average scores for POV 3 (3.33 and 4.45, respectively) are significantly higher than that of POV 1 (2.95 and 4.18, respectively). There is no significant difference between these perspectives and POV 2 (3.15 and 4.20, respectively).

Regarding the respondents from Spain, the repeated measures ANOVA test shows that there is a significant difference in score for bikeability ($F(2, 134) = 4.11, p < 0.05$). The pairwise comparison tests at the confidence level of 95% show that bikeability score in POV 3 (3.68) is significantly higher than that of POV 2 (3.31). There is no significant difference between these perspectives and POV 1 (3.40).

To compare the scores from both groups of respondents, independent sample t-tests were performed at the confidence level of 95%. For POV 1, it is found that respondents from Spain (3.49) are more likely to choose cycling than respondents from France (2.95). Respondents from France have higher walkability rating (4.49 and 4.12) and are more likely to choose walking (4.45 and 4.13) for POV 3 than respondents from Spain. Meanwhile, the average scores between the two groups are not statistically different for POV 2.

4. Discussion

When dealing with qualitative evaluation of the streetscape, there is some commonalities between French and Spanish opinions. When given a choice between Balance, Grandeur and Restlessness to characterize Scale and Size of the buildings, both groups responded approximately the same. Architectural style rating was also coarsely distributed the same for both groups across the possible characterization proposed and across all POV. Auditing of the Materials component presented the most intercultural variability: Spanish

corpus seeing more the Warmth/Comfort in the sceneries, while French group was more ambivalent between the proposition of qualification.

When asked about giving a general feeling of the three urban identities, both corpus of participants responded in majority Indifference/Unnoticed. But Spanish people were more likely to provide a proposition of qualification other than Indifference, mostly Emotion/Spirituality and Joy/Theatricality, while French voted Joy/Theatricality if they decided to express a feeling.

When comparing responses from both population of the sample, PLOS-TQM and SUMI-QPS indicators gave sensitively the same result. This result tends to prove that those indicators are reliable and robust to the intercultural variability in public space auditing.

There is more cross-cultural variability when dealing with direct probing of active mobility assessment. Respondent from France gave higher scores for walkability and their appetite of choosing to walk compared to respondents from Spain. Bikeability of in the three POV where coarsely the scored the same amongst French and Spanish, as well as the tendency to opt for cycling as a way of transportation. The vital role of visual attractiveness in cycling might explain this finding, which is shown in the preference of all respondents in choosing to cycle in POV 3. These findings are in line with existing research that streetscape attractiveness increases route choice for active mobility (Müggenburg et al., 2022; Tabatabaie et al., 2023). In addition, existing research found a positive correlation between streetscape visual attractiveness and active mobility for leisure purposes, i.e., transport purpose, leisure purpose, and physical activity (Belaroussi et al., 2023; Juul and Nordbø, 2023; Ramirez Juarez et al., 2023).

The scores from both respondent groups, i.e., from France and Spain, were compared in this research. It is shown through the independent sample t-test that, in general, there is minor difference in the cyclability and the choice of cycling as a mean of transportation for respondents from France and Spain. One explanation that might explain this finding is that both groups have similar exposure to active mobility behavior being geographically located in Europe. Walking and cycling are popular choices for short-distance trips in European cities after cars.

Conclusions

The perception of users from different cultures or countries when walking through an urban space can vary significantly due to cultural, social, and economic factors. In a residential area, expectations of safety, cleanliness, and accessibility are crucial. In some cultures, tranquility and privacy are more valued, while in others, a more community-oriented and active environment is preferred. Users from countries with a strong cycling culture, such as the Netherlands, may find urban designs that facilitate cycling more favorable, with well-marked and safe bike lanes. On the other hand, in places where walking is the norm, such as many European cities, pedestrian infrastructure is prioritized, with wide sidewalks and safe crossings.

In commercial spaces, user perception can be influenced by the availability of well-planned pedestrian and cyclist areas. Comfort and safety in traveling to these spaces are also determining factors in user perception. Urban parks and gardens are also perceived differently depending on the culture and country. In cultures that value nature and outdoor recreation, a design that promotes both walking and cycling, with integrated paths that do not disrupt the natural experience, will be appreciated designed to be accessible to both pedestrians and cyclists, promoting sustainable mobility and physical exercise. In general, user perception when walking through an urban space varies widely depending on cultural and national factors. Designs that effectively integrate both pedestrian and cycling mobility tend to be the most valued, as they offer flexibility and sustainable transportation options. However, it is essential to consider the specific characteristics and cultural expectations of users to create inclusive and functional urban spaces.

In this research, we selected three urban identities (POV) in a modern district which is in construction in Paris (France), and we implemented methods to characterize public spaces elements for public auditing. For each of the POV (public plaza with a tramway station, commercial street, and green residential area), a video of one minute of each of these spaces was proposed to a public audience in two experimentations: one in VR and one with real scenes. A set of questions were asked, specific to the streetscape and the characterization of the urban vibes. The corpus of auditor participants was made up by a French group (settled in Paris) and a Spanish group (settled in Canary Islands), which allowed us to make comparisons across cultural influences related to their satisfaction, evaluating

various elements such as the perception of the urban landscape, architectural style, green spaces, and the mobility of citizens through the three POV proposed.

Four variables were analyzed: scale and size, related to the perception of balance, restlessness, greatness and scale and size; the architectural style, related to emotions such as surprise, satisfaction, serenity, simplicity, and elegance; the materials, which produce sensations such as distance, frigidity, fragility, exposure, sobriety, coldness, warmth and comfort; the general sensation, related to the experience that provokes, which is related to emotion, spirituality, joy, theatricality, sadness and nostalgia. The perceptions of balance, simplicity / serenity and comfort / warmth predominate in the three POV and for the two groups of auditors. However, the analyzes indicate differences in perceptions between both groups for the materials component and about the general feeling for the different spaces.

Along with the previous qualitative evaluation, two aggregated indicators were also analyzed in each scenario and for each group: Pedestrian Level of Service–Trip Quality Method (PLOS-TQM) and Sustainable Urban Mobility Indicator–Quality of Public Space (SUMI-QPS). Comparisons have been established between both groups to understand the differences and common points in the perception of public spaces in both cultures.

Regarding the analysis of mobility applying the two indicators, we could consider from a general point of view that both groups coincide in the perception or sensation space produces. However, applying statistical techniques, some differences are highlighted. According to the French group, Walkability and the choose to walk through on the three POVs, are valued

as very walkable spaces, however, the Spanish group are more conservative, and they consider them simply walkable. It is true that POV3 (leisure and recreation area) is considered very passable by both groups of auditors.

On the other hand, the Spanish value the three POVs as very positive for traveling by bicycle, although the French group also value it positively, but to a lesser score. Perhaps it is a consequence of the fact that, for residents in the Canary Islands, flat and wide spaces give them a greater feeling of security when traveling by bicycle, since spaces of these characteristics are not common in Canary Islands cities, due to their urban design and orography. The French group does not value residential and commercial spaces as positively as the Spanish group for bicycle mobility, perhaps based on their experience as users of bikes in the city (lane width, spaces, safety at intersections, park bikes, etc.).

A first perspective of this work is to enrich the set of questions to allow for more explanatory characterization of urban ambiances. Indeed, we have found that a direct questioning of participants about the sensation brought by various environments was not discriminative of places enough. Also, other aspects need to be addressed more specifically: tidiness, imageability, and transparency. Another possible extension would be to add physiological sensors such as EKG and EEG, emotion recognition software. And study the benefit of such apparatus for this kind of psychology study across culture.

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