

# Visual attention towards building façades in the most energy vulnerable neighbourhoods in Madrid and the relaxing effect of visual coherence

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## Resumen

Este estudio forma parte del proyecto mateMad que tiene como objetivo optimizar los materiales urbanos para hacer que los barrios desfavorecidos sean más habitables y sostenibles. El objetivo de este estudio preliminar es analizar la atención visual y el compromiso humano-fachada hacia las fachadas de edificios en barrios desfavorecidos en Madrid con el fin de crear barrios hermosos, sostenibles e inclusivos. La falta de simetría a lo largo del eje vertical y un tamaño geométrico no similar de las ventanas, mantenimiento deficiente, falta de transparencia de las ventanas y homogeneidad en color y textura resultaron en una mayor angustia subjetiva reportada, mientras que la simetría horizontal/vertical y la misma forma/tamaño de ventana resultaron en menos angustia.

## Palabras clave

Diseño de edificios, salud ambiental de las viviendas, percepción de los entornos construidos, malestar subjetivo informado, entorno construido sostenible

## Abstract

*This study is part of the mateMad project that aims to optimize urban materials to make deprived neighbourhoods more liveable and sustainable. The objective of this preliminary study is to analyse visual attention and human-façade engagement towards building façades in deprived neighbourhoods in Madrid to the end of creating beautiful, sustainable, and inclusive neighbourhoods. A lack of symmetry along the vertical axis and a-similar geometrical size of windows, poor maintenance, non-transparency of windows, and non-homogeneity in colour and texture resulted in more reported subjective distress, whereas horizontal/vertical symmetry and same window shape/size resulted in less.*

## Keywords

*Building design, environmental health of housing, perception of built environments, subjective reported distress, sustainable built environment*

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## 1. Introduction

Good mental health is a central part of overall health and well-being. Mental health challenges, such as loneliness affect 84 million people across Europe (European Commission, 2022a). In the European Union, Spain is labelled as one of the 8 countries with the highest intensity of lonely places (European Commission, 2022b). Moreover, the World Health Organization considers social disconnection as a major public health risk for increased morbidity and mortality, which has been already clearly evidenced during the COVID-19 isolation (Rokach & Boulazreg, 2022). A good understanding of what characterizes this vulnerability in cities, is crucial for the development and implementation of urban policies in order to ensure the wellbeing and thus the quality of life of citizens living in these places.

In this view, the “Catalogue of Vulnerable Neighbourhoods” (Hernandez, A. et al., 2018) mapped urban deprived areas in Spain, using as indicators of deprivation 1) the percentage of population without education, 2) a job and, 3) living in dilapidated, poorly maintained buildings. Unsustainable housing and high energy prices increase the risk of socio-economical inequality and make neighbourhoods more vulnerable for physical and mental health problems (Wilkinson, 2010).

Against this backdrop, the Most Energy Vulnerable (MEV) methodology identifies in Madrid those housings that potentially experience limited access to sustainable and affordable energy supplies in both summer and winter (Martin-Consuegra, F. et al, 2020). This is to say, MEV analyses areas that suffer from the urban heat island effect (UHI) in summer as well as energy poverty in winter (Fig. 1.)

To understand the built environment of these neighbourhoods it is essential to take the Homogenous Urban Zones classification as well into consideration. Based on Madrid’s urban morphology, land cover and building’s construction characteristics, the Homogenous Urban Zones methodology (HUZ) aims to classify and identify the most representative built areas in built in the city of Madrid (Fig. 2.) (López-Moreno et al., 2022).

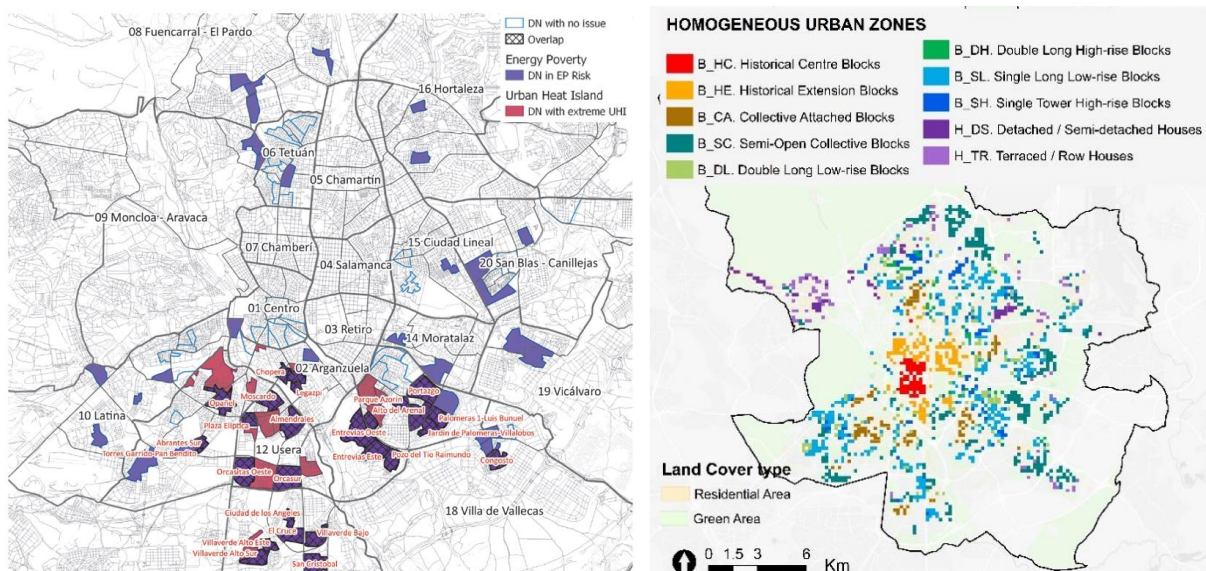


Fig. 1. Most Energy Vulnerable neighbourhoods (MEV): deprived neighbourhoods (DN) with risk for Energy poverty (EP) and extreme UHI values in Madrid. Source: own elaboration.

Fig. 2. Identified Homogenous Urban Zones (HUZ) in the city of Madrid. Source: own elaboration.

Unsustainable housing and social vulnerability of deprived neighbourhoods can have a cumulative negative mental health impact on local population groups. To tackle the socio-economic and climate challenges in Madrid's deprived neighbourhoods, it is time to initiate urban renovation. In fact, high quality housing has become more relevant within the context of the current New European Bauhaus (NEB) initiative. This is to say, the European Union (EU) has developed a new instrument that invites all Europeans to build together sustainable and inclusive cities (European Commission, 2022c). With the NEB initiative the EU intends to bring the European Green Deal to our urban lives and living spaces. The NEB initiative not only aims to make our societies more sustainable, but also strives for quality of experience and style beyond functionality (aesthetics) and inclusivity (diverse, accessible and affordable cities). The idea behind this vision is that the environment that supports a healthy mental state may create significant psychological and physical benefits (European Commission, 2022d).

This study will focus on the impact of the built environment on human wellbeing in the most energy vulnerable neighbourhoods in Madrid. In this regard, it is essential to understand why there are urban places that encourage happiness in cities, more than others. Some studies revealed already how the characteristics of the built environment impact our emotions, behaviour and our physical well-being (Bower, Tucker, & Enticott, 2019). Past researchers (Weber et al., 1995) analysed for example the impact of formal properties, such as size, contrast, symmetry on eye movements and explored the positive effect of different natural and urban settings on the parasympathetic nervous system (Ulrich et al., 1991). Other studies pointed out how the human brain looks for visual coherence in urban settings, as found in nature (Salingaros & Sussman, 2020). Moreover, there has been even software developed that can simulate visual attention towards building characteristics (Lisińska-Kuśnierz & Krupa, 2020). The advantage of the 3M Visual Attention Simulation Software (3M VAS) is that it simulates human responses to visual stimuli without laboratory set up (Zhang et al., 2022). The software scans a photo and then predicts where the eye will fixate. The heatmap then presents the intensity of attention in colour codes. An example of a visual attention simulation to building façades is the study developed by Salingaros & Sussman (2020) where visual attention was simulated towards the paintings of 5 different types of building façades: notably a classical/baroque, art deco building, a contemporary building with vertical windows aligned horizontally, and a contemporary building with unaligned vertical slit windows.

Self-reporting assessments in addition to this visual attention simulation are helpful to explore the effect of visual attention on human's subjective level of distress (Kim et al., 2008; De La Fuente Suarez, 2020). Shapiro (1989; 2014) found for example a change in subjective distress when moving her eyes in a multi saccadic way during a recall of an anxious situation. Moreover, research confirmed that horizontal eye movements may result in increased parasympathetic nervous activation and thus have a relaxing effect (Aubert-Khalifa, Roques, & Blin, 2008).

In short, as urbanization increases worldwide, it is essential to understand why there are urban places that improve human wellbeing more than others (European Commission, 2022e) and initiate urban renovation to the end of enabling inclusive wellbeing in all cities (Rajendran et al., 2020).

## 2. Objective and structure

This study aims to detect visual attention parameters in building façades to the end of developing an approach to optimize building façades and therefore as well the liveability in deprived neighbourhoods in Madrid.

In this view, this study first characterizes and selects representative façades in Madrid according to their vulnerability indicators and urban characteristics, then identifies visual parameters that influence citizens wellbeing via a visual attention simulation, structured electronic survey (e-survey) and

participatory design, and finally it defines positive visual parameters to take into consideration for urban renovation.

In this regard, the methodology will be described in Section 3. The results, followed by a discussion will be addressed in Section 4 and Section 5. Finally, Section 6 will present the conclusions. Suggestions for a follow-up study will be outlined lastly.

### 3. Methodology

#### 3.1. Selection of representative building façades in Madrid's deprived neighbourhoods

This study focuses on the optimisation of building façades in deprived neighbourhoods of Madrid. For the selection of representative buildings, the Most Energy Vulnerable methodology (MEV) was used where 27 deprived neighbourhoods were identified with a risk of urban heat island effect (UHI) in summer as well as energy poverty in winter (Figure 2). The mateMad project identified Delicias, Picazo, Orcasur Oeste, Orcasitas as the most vulnerable areas with a high potential for urban renovation (Martin-Consuegra, F. et al, 2022).

Within the selected neighbourhoods a representative building was selected based on their most predominant Homogenous Urban Zones (HUZ) classification (López-Moreno, H. et al., 2022). The HUZ method determinates representative building blocks considering its land cover, urban morphology and building construction. The methodology has been applied in Madrid, where it identified 10 HUZs. Fig. 3. maps the Most Energy Vulnerable Neighbourhoods in the city of Madrid that are selected for this study and presents their HUZ classifications.

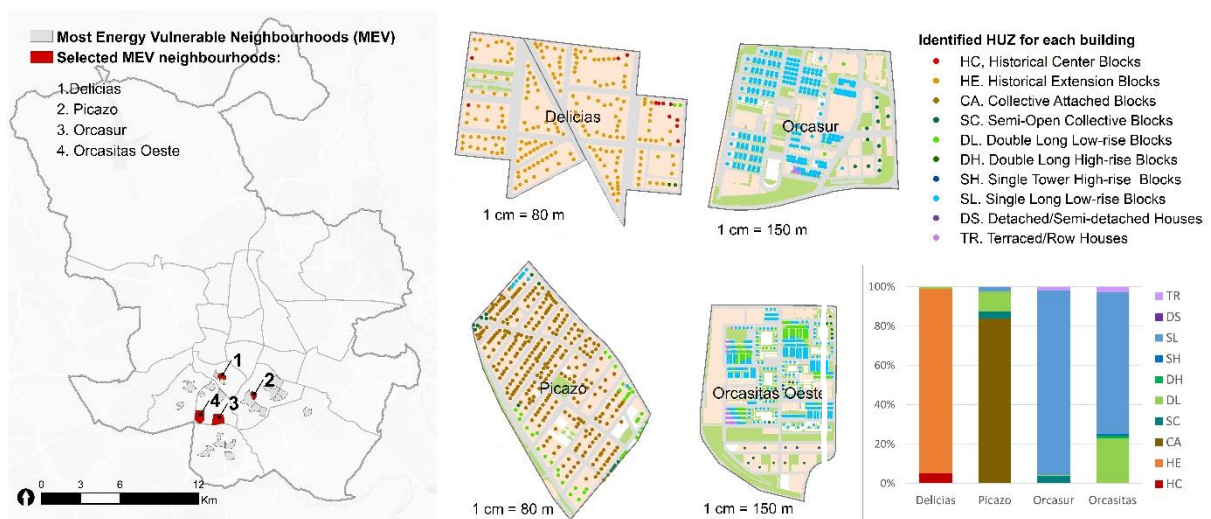


Fig. 3. Map of identified and selected MEV neighbourhoods in the city of Madrid (left) HUZ classification and quantification of selected MEV neighbourhoods (right). Source: own elaboration.

The most representative class within Delicias is the Historical Extension Blocks (HE) representing 94% of its buildings, while in Picazo the most repeated HUZ class with a 84% representation is the Collective Attached Blocks (CA). Both HE and CA belongs to the compact block areas from the early second half of the 20th century characterized by their low ratio of pedestrian and green areas. HE class, which was developed close to the city centre, has higher-rise constructions but their density of buildings is lower compared to CA, which has lower-rise built-up areas, but the density of buildings is higher.

On the other hand, Orcasur Oeste and Orcasitas are mainly characterized for having sprawl areas, where Single Long Low-rise Blocks (SL) is the predominant HUZ class with 94% and 72% respectively.

This class is known for their urban sprawl of mid-to-late 20th-century buildings, marked by their large walkable and public green areas located between the primary and the last peripheral city ring. They were constructed in the mid-50s until the late 80s. Specifically SL is one of the most predominant HUZ in Madrid. It is shaped by single longitudinal dwelling rows of approximately 4 to 8 floors height.



Fig. 4. Map and google streetview of the selected building façades in MEV neighbourhoods of Madrid. Source: own elaboration

For this study, a representative building that belongs to the most predominant HUZ in each of selected neighbourhoods has been determined. This is to say, residential constructions were evaluated and selected based on their proximity to the mean values of the HUZ land cover, urban morphology and building construction indicators. Therefore, in Delicias C. Divino Vallés, 12 (1) was selected, C. Martell, 32 (2) was chosen in Picazo, while Av. Orcasur, 17 (4) and C. de Gainza 11 (5), were defined in Orcasur Oeste and Orcasitas respectively.

After verification of the in-person approachability of the building façade a final selection was made. In fact, due to construction works at the façade of (4) in April 2022, the preselected case study was replaced by another similar representative building in Orcasitas, notably: (4\*) C. de Cestona, 36, Madrid, Spain. Also, an additional representative building type SL was added in the list in view of alternative visual parameters (i.e. window geometry/alignment), notably (5) C. Campotejar, 36, Madrid, Spain. Fig. 4. describes the location of these selected buildings, detailing their urban context and the characteristics of their façades.

### 3.2 Photo inventory

A photo inventory was made consistent with requirements in other visual attention studies based on a standard framing and perspective (Salingaros & Sussman, 2020). The 5 photos were taken in the street in front of the façade with a distance of 5.00 m (Le et al., 2017) (Table 1). To standardize the angle of the photos, the photos were taken at eye level of the photographer, at the height of 1.65 m, perpendicular in front of the façade, to the end of incorporating at least 2 floor levels of the building. Hollander, et al. (2021) have illustrated in their study that a photo within a larger coloured background frame (blue sky) improved the accuracy of the visual attention simulation. Following this logic, the photos were placed on a blue/white background. In fact, previous studies have shown that buildings without clouds on the blue frame expressed more accurate architectural information than without (Lavdas, et al., 2021).

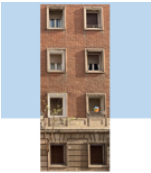




1	2	3	4	5
C. Divino Vallés, 12	C. Martell, 32	Av. Orcasur, 17	C. de Cestona, 36	C. Campotejar, 13
				

Table 1. Photo inventory of the selected building façades in MEV neighbourhoods of Madrid placed on a blue/white background. Source: own elaboration.

### 3.3 Experimental set-up

#### *Visual Attention Simulation*

Following the Salingaros & Sussman study (2020), this study uses the 3M VAS tool as instrument to analyse the first 3-5 seconds of visual attention towards 5 building façades in the city of Madrid (Table 2; Step 1).

	Step 1	Step 2	Step 3
<b>Method</b>	Visual Attention Simulation	Structured e-survey	Participative design
<b>Tool</b>	3M VAS software	EU Survey platform	Miro platform / paper drawing

Table 2. Methodology. Source: own elaboration.

Visual attention software attempts to mirror human gazing (Salingaros & Sussman, 2020), but given it is a computer simulation, and the human perception is a very complex neurological process, it was decided to assess visual perception towards the built environment additionally via a structured e-survey and participative design (Table 2; Step 2 & 3). A written informed consent was asked to the participants in advance.

#### *Participants*

The participants for this preliminary study were recruited in the Universidad Politécnica de Madrid based on the snowball sampling method with some students of a Professor in Architecture as starting point. The snowball sampling method is a non-probability sampling technique used in qualitative research to identify and recruit participants. After interviewing these initial participants, each participant was given the opportunity to reach out to additional participants, hence the term "snowball".

However, it is important to note that snowball sampling has some limitations. Since participants are recruited based on referrals from existing participants (convenient sampling method)(Noy, 2008), there is a risk of bias and homogeneity within the sample, as individuals tend to refer others who have a similar background as themselves. Additionally, the method may not result in a representative sample of local case study population, making it challenging to generalize findings to a broader context. Despite these limitations, snowball sampling remains a valuable tool in qualitative research for generating rich, in-depth insights when population groups are difficult to reach.

This paper presents findings from a focus group study conducted with promising young students/professionals in architecture, engineering, and urban design. Seven female participants and two male participants were able to participate. The following inclusion criteria were used:

- visual ability (if necessary, with correcting glasses/contact lenses)
- population (adults of 18+ years old)
- academic background (higher education in field of architecture, engineering, urban design)
- language (Spanish or English speaking)

Through analysis of the bilateral discussions, valuable insights were obtained, shedding light on various aspects of facade design and cognitive, emotional and physical awareness. The findings (see results) highlighted the importance of consulting with experts to inform decision-making processes and enhance the quality of research outcomes in the built environment. By recognising the importance of harnessing this expertise and bringing together young minds with diverse backgrounds and perspectives, the research aimed to explore key issues and challenges in the domain of built environment.

#### *Structured e-survey*

A structured e-survey was set-up to measure self-reported visual attention towards the building façades and to evaluate subjective reported distress. EU survey was used as online platform for the questionnaire and was completed via a PC either in class (Universidad Politécnica de Madrid) or via a remote connection (teams) and took between 30-40". The e-survey started with a short-written description in Spanish (since this was the preferred language of the participants) explaining the objective of the study, after which the possibility was given to ask questions regarding the instructions. Table 3 illustrates the instructions (translated from Spanish to English).

Table 3 Translated instructions of the e-survey from Spanish to English.

Instructions and questions e-survey
<i><u>Objective.</u> Building façades concerns all stakeholders, from city dweller to local, regional, international tourist. This study aims to understand cognitive, emotional and physical awareness of the building design and the human-façade engagement in outdoor public spaces. The purpose of this prestudy is to gather views on human-façade engagement in outdoor public space. The targeted audience are (student) architects, urban planners, engineers.</i>
<i><u>How to fill in this questionnaire?</u> You will see photos of buildings from different areas in Madrid. Imagine yourself in front of the façade in outdoor public space and score how you experience seeing the façade (via the scale scoring). The survey can be completed in Spanish or in English.</i>

The questionnaire itself started with questions on demographical info (to the end of checking the above-described inclusion criteria). Afterwards the five photos of the case study were presented with a duration of 10 seconds. Each photo was separated by a grey slide (Fig. 5.). The reason to double the gazing time frame (in comparison with the 3-5 seconds pre-attentive gazing of the VAS) was to allow the human brains to process the seen visual cues consciously and to be able to report about them. The photos were presented on a separate screen in a small classroom (Universidad Politécnica de Madrid) or remotely via desktop sharing (via teams).



Fig. 5. Structured e-survey : experimental set-up. Source: own elaboration.

Following Le et al. (2017) a 7 item Likert scale and body mind map (Skop, 2016) were presented via the e-survey (Table 4) to the end of measuring reported subjective distress (Kim et al., 2008) related to visual attention towards the 5 building façades.



Table 4 Questions e-survey.

Q1 - Which thought do you have seeing this façade?	Q2 - What emotion do you feel seeing this façade?	Q3 - What feeling do you have in your body seeing this façade?	Q4 - Where do you experience that feeling in your body seeing this façade (see front/back body map below)? Indicate with number'(s) according to the categories in the body map.	Q5 - What effect does the façade have on your human-building engagement in outdoor public-space?
Likert scale	Likert Scale	Likert Scale	Mind body map	Likert Scale
(1) greatest imaginable discomfort	(1) Happiness	(1) completely stressed	(1) Front :1-30	(1) completely disengaging
(2) very uncomfortable	(2) Surprise	(2) very stressed	(2) Back: 31-60	(2) very disengaging
(3) slightly uncomfortable	(3) Sadness	(3) slightly stressed		(3) slightly disengaging
(4) neither comfortable, nor discomfortable	(4) Anger	(4) neither relax, nor stressed		(4) neither engaging, nor disengaging
(5) slightly comfortable	(5) Disgust	(5) slightly relax		(5) slightly engaging
(6) very comfortable	(6) Fear	(6) very relax		(6) very engaging
(7) greatest imaginable comfort		(7) Completely relax		(7) completely engaging

Source: own elaboration.

#### *Participatory design: interview technics of in-depth interview*

The timing of part 2 of the study was agreed with the participant after the completion of the structured e-survey. Considering COVID-19 precautions, the participants had also the choice to participate remotely or in person. The students who decided to participate in the participatory design in-person were welcomed in a small office in the Universidad Politécnica de Madrid.

The process of the in-depth interview during the participatory design was defined before the interview took place with the objective to interview the participants in a similar manner and to maximize the reliability of participatory design. This is in compliance with the phenomenological research method, where the main principle is to limit the interference of data collection by theory, experiences or normative framework of the researcher (to the end of maximizing the objectiveness of data collection) (Braun & Clarke, 2006).

The in-depth interview question during the participatory design assessed the motives behind the scores of the e-survey (“draw/write on the photo which elements of the façade made you score that way in the structured e-survey?”). The interview took in total 40-60 minutes.

## 4. Results

Visual attention towards the HE, CA, SL building façades of the Most Energy Vulnerable Neighbourhoods was simulated with the 3M Visual Attention Software (VAS). This was followed by self-reported assessments, notably a structured e-survey and a participatory design exploring conscious visual attention towards the building façades and their subjective reported distress.

### 4.1 Visual Attention Simulation

The visual attention simulation shows in a heatmap the intensity of pre-attentive fixation spots over the first 3-5 seconds of visual gazing, in which the intensity of attention was color-coded: black (none), blue (low), green (medium), red (considerable), dark red (maximum) (Table 5). The heatmaps indicate that windows and human/natural elements are the most important indicators for pre-attentive fixation in all building façades. Especially those elements that break the planned harmony of the façade such as air conditioner machines, decorative plants' pots as well as opened windows or those ones that have shutters drawn. HE and CA typologies show more homogeneous intensity of attention for all the façade, while in SL buildings differences in the heat map are more remarkable.






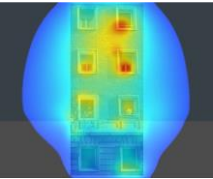
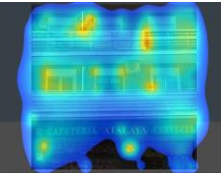
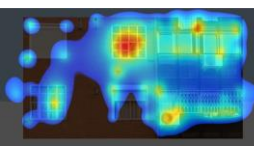
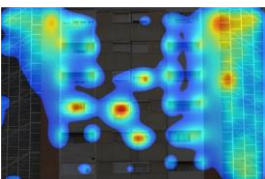
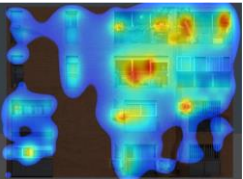
1	2	3	4	5
C. Divino Vallés, 12	C. Martell, 32	Av. Orcasur, 17	C. de Cestona, 36	C. Campotejar, 13
(HE)	(CA)	(SL)	(SL)	(SL)
				
				

Table 5. Simulated visual attention towards different types of building facade in deprived neighbourhoods in Madrid. Source: own elaboration.

### 4.2 Structured e-survey

The scores of the e-survey are visualized in graphs to the end of analysing the subjective reported distress related to the building façades as well as to measure the likelihood of human- façade engagement. The graph in Fig. 6. indicates that photo 4, C. de Cestona, 36, was cognitively perceived as most comfortable building façade, whereas photo 2, C. Martell, 32, as the least. Photo 3, Av. Orcasur, 17 and especially photo 5, C. Campotejar 13, present the widest spectrum of cognitive awareness. Finally photo 1, C. Divino Vallés, 12 has the most neutral values.

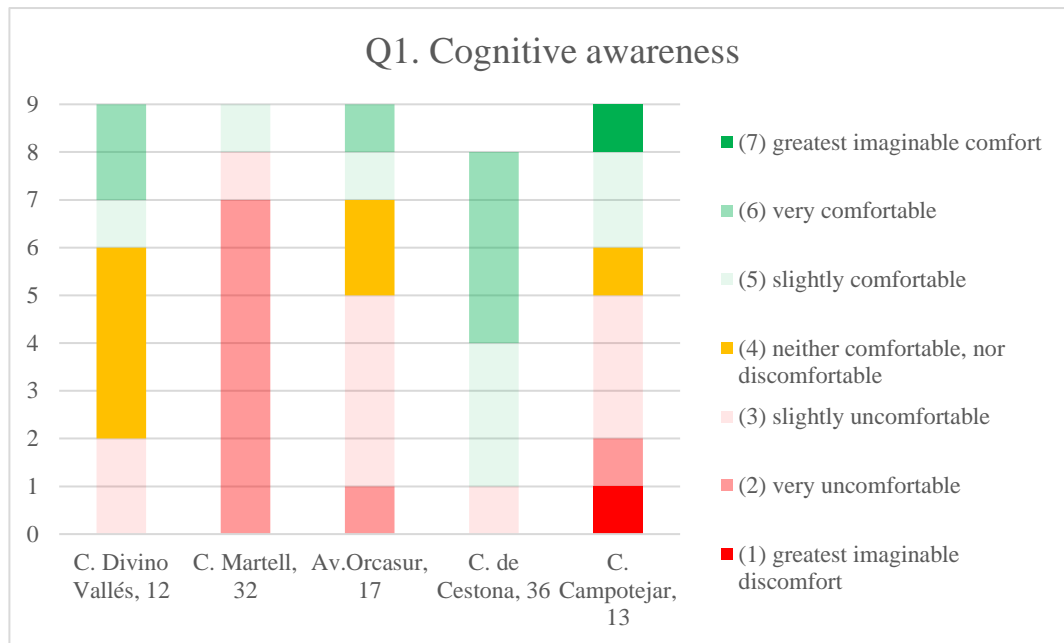


Fig.6. Cognitive awareness towards different types of building façade in deprived neighbourhoods in Madrid. Source: own elaboration.

Fig. 7. presents the emotions felt looking at the photos of the building façades. Happiness was reported mostly for photo 4, C. de Cestona 36 ; surprise mostly for photo 3, Av. Orcasur, 17; sadness, mostly for photo 1, C. Divino Vallés, 12; anger both in small quantity for photo 3, Av. Orcasur, 17 as for photo 5, Av. C. Campotejar, 13. And disgust was mainly reported for photo 2, C. Martell, 32. Fear was reported for none of the building façades.

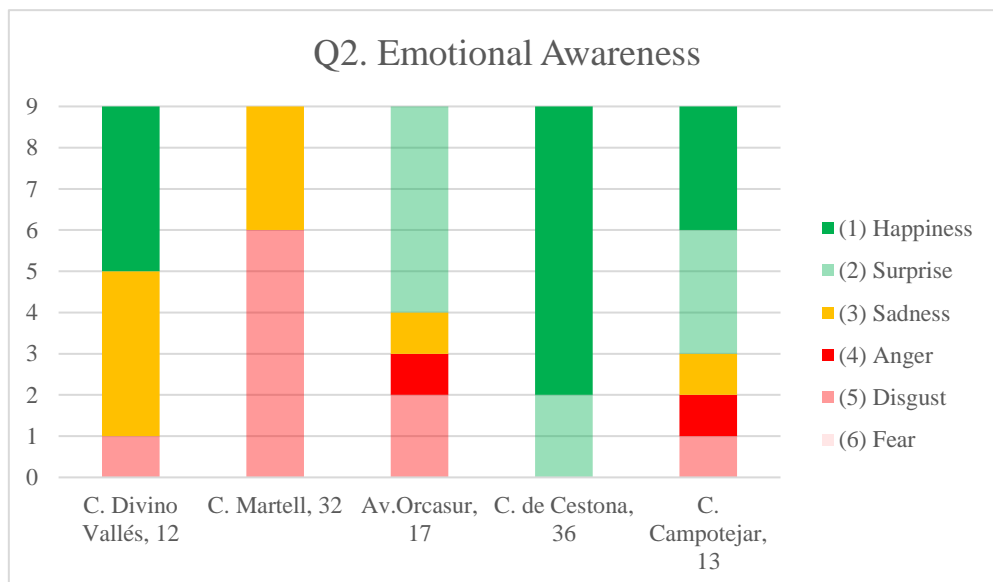


Fig. 7. Emotional awareness towards different types of building façade in deprived neighbourhoods in Madrid. Source: own elaboration.

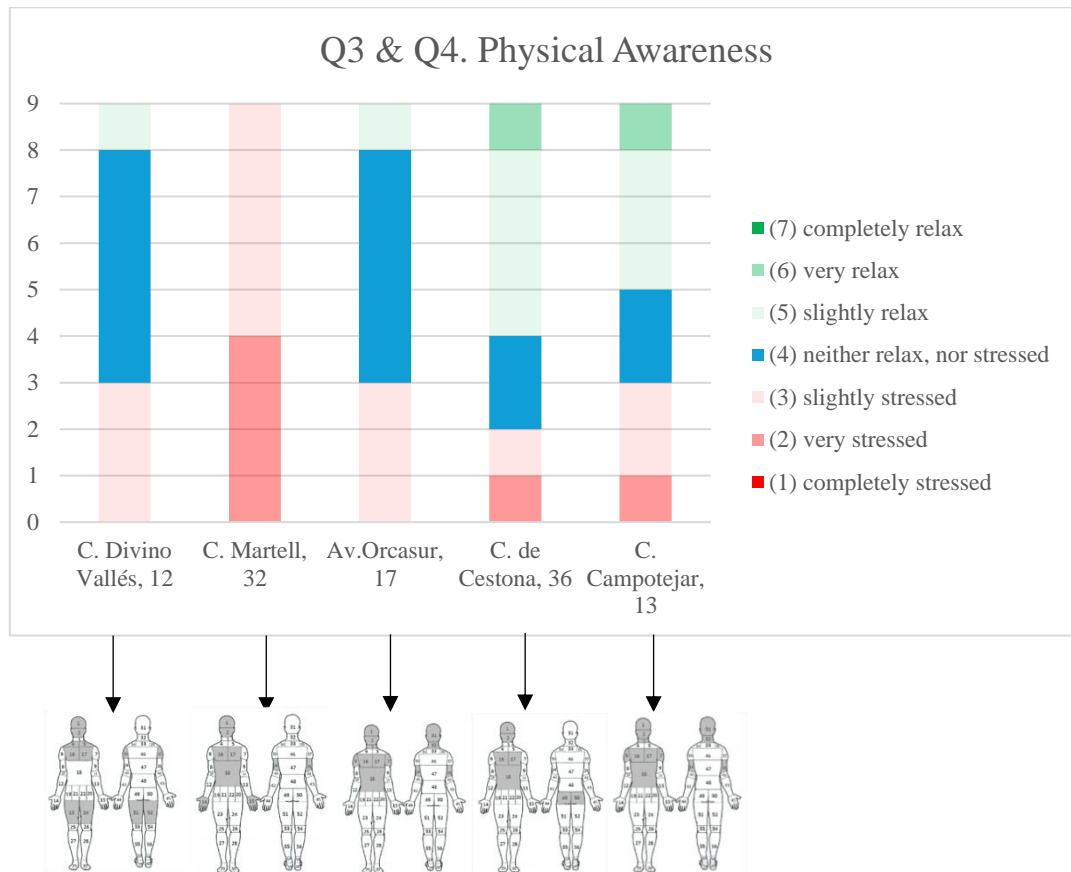


Fig. 8. Physical awareness towards different types of building façade in deprived neighbourhoods in Madrid. Source: own elaboration.

The graph in Fig. 8. indicates that photo 2, C. Martell 32, induced most stress in participants, whereas photo 4, C. de Cestona 36 and photo 5, C. Campotejar 13 were perceived as at least slightly relaxing. The awareness of both physical states were experienced mainly in front head and upper front body.

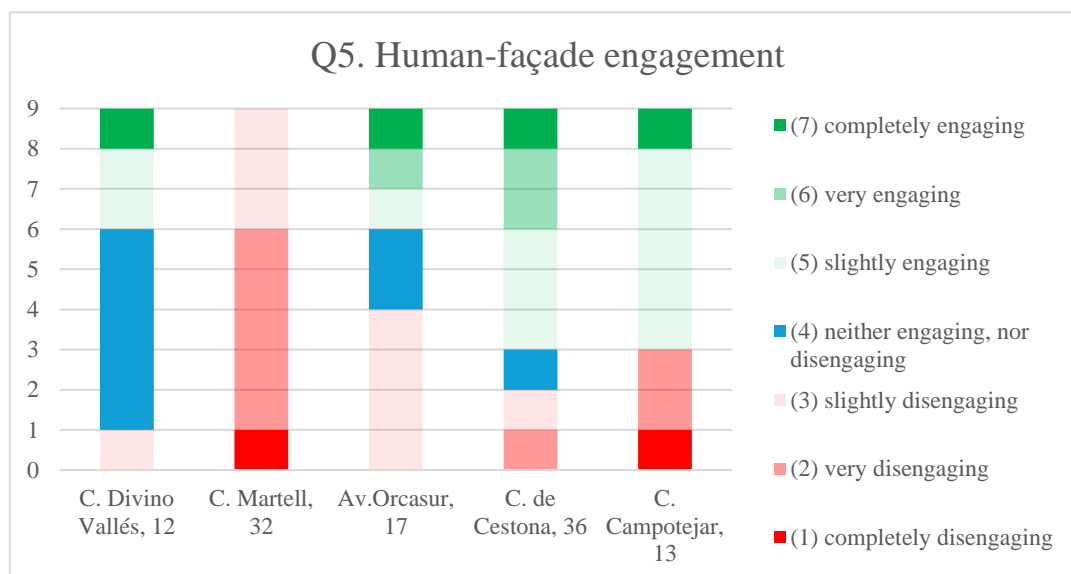


Fig. 9. Human-façade engagement towards different types of building façade in deprived neighbourhoods in Madrid. Source: own elaboration.

The graph in Fig. 9. presents the human-façade engagement towards the different building façades. Photo 4, C. de Cestona, 36 and photo 5, C. Campotejar, 13 were scored by most participants as at least slightly engaging. Photo 2, C. Martell 32, was reported as most disengaging.

### 4.3 Participatory design

All recordings of the in-depth interviews were transcribed for analysis. The audios were checked against the participatory design and encoded (in case of relevance to the research question) in meaningful units and condensed to categories to the end of making a drawing compilation for each façade. The drawing compilation was then compared with the visual hotspot maps of the 3M visual attention simulation, where the intensity of intensity of attention was color-coded: black (none), blue (low), green (medium), red (considerable), dark red (maximum) (Table 6).

#### 4.3.1. C. Divino Vallés, 12. Historical Extension Blocks (HE)

As presented in Table 6, both the simulated as the self-reported fixation spots indicated that the horizontal/vertical symmetry and same size and shape of the windows resulted in cognitive entanglement. The windows of this historical extension block were perceived as a coherent aligned structure, that increased human-façade engagement and reduced reported subjective distress. However, contrary to the visual attention simulation, the maintenance and non-transparency of some windows (closed window shutters) and non-homogeneity in colour and texture between upper and lower part of the façade were reported as causing sadness and disengagement. On the other hand, the human element, placed in the (right) window frame on the first floor, was reported as a relaxing, engaging visual cue.

#### 4.3.2. C. Martell, 32. Collective Attached Blocks (CA)

In photo 2, C. Martell, 32 (Table 6) the windows are not aligned vertically. The fact that sub-symmetries are missing in this collective attached block, resulted in cognitive disentanglement and more self-reported subjective distress. This is to say, the participants reported disengagement with the building façade as result of a lack of symmetry along the vertical axis and size/geometry of windows. However, contrary to the visual attention simulation, the aluminium balustrade, coloured letters and graffiti in the lower part of the building strongly attracted the visual attention of the participants but were reported as uncomfortable and classified as disgust. In sum, the maintenance of the façade, the transparency (closed window shutters) and ventilators were reported as disengaging elements.

#### 4.3.3. Av. Orcasur, 17. Single Long Low-rise Blocks (SL)

Contrary to the visual attention simulation, visual attention towards this single long low-rise block was also drawn to the vertical axis between the two types of materials in the left/right side of the building. The fact that sub-symmetries were missing resulted in cognitive disentanglement. Participants reported mostly surprise and in little quantity anger when looking at the difference in colour/material, window grid, its maintenance, non-transparency (closed windows shutters), ventilators, and a-similar window size/shape. The human elements (drying towels) were perceived as positive engaging, breaking the non-transparency of the largely present window grid.

	C. Divino Vallés, 12 (HE)	C. Martell, 32 (CA)	Av. Orcasur, 17 (SL)	C. de Cestona, 36 (SL)	C. Campotejar, 13 (SL)
	Historical extension block with similar size/shape windows aligned horizontally/vertically	Collective attached block with similar size/shape vertical windows aligned horizontally	Single long low-rise block with a-similar size/shape vertical windows aligned horizontally	Single long low-rise block with similar size/shape vertical windows aligned horizontally / vertically.	Single long low-rise block with a-similar size/shape vertical windows aligned horizontally
1					
2					

Table 6. Comparison 1. simulated visual attention (3M VAS) versus 2. self-reported fixation spots towards different types of building façade in deprived neighbourhoods in Madrid. Source: own elaboration.

#### 4.3.4. C. de Cestona, 36. Single Long Low-rise Blocks (SL)

In photo 4, C. de Cestona, 36 the windows have the same shape/size and are aligned horizontally and vertically. This single long low-rise block was scored by most as (at least slightly) engaging. The participants reported reduced subjective distress when looking at the façade due to the symmetrical organization of the material and the transparency of the stair hall. This is the result of visual coherence. However, the non-transparency of certain windows (deep terraces/stair hall raster) and texture of the middle part of the façade (concrete) were reported as slightly disengaging.

#### 4.3.5. C. Campotejar, 13. Single Long Low-rise Blocks (SL)

In photo 5 the windows do not have the same shape and size and are not aligned vertically. The fact that sub-symmetries are missing in this single long low-rise block resulted in cognitive disentanglement. In addition, comparable with the simulated fixation spots, self-reported fixation spots were drawn towards human and natural elements, hence this façade was scored as (at least slightly) engaging. Non-transparent visual cues, such as window shutters/rasters were reported as disengaging, increasing reported subjective distress.

Finally, results show, in general terms there was no discernible pattern across the variables describing demographic characteristics such as age, level of education or field of study. While initially assumed that age might influence respondents' perspectives, with younger individuals and thus potentially illustrating different attitudes compared to older participants, the findings did not support this hypothesis. Similarly, the assumption that varying levels of education (bachelor, master, pre/doctorate) might lead to diverse viewpoints was not confirmed, the data did not reveal any significant trends. Furthermore, this study initially expected that individuals' fields of study could impact their responses, but this did not emerge as a defining factor either.

Despite the lack of clear patterns, it is essential to acknowledge the limitations and advantages of this analysis (see below). In general terms, this study outlines the diversity and complexity of human experiences and viewpoints. The results highlight the importance of considering individual perspectives rather than relying solely on broad generalizations based on demographics or field expertise.

## 5. Discussion

The findings of this study provided a few insights into the role of façade design-attention in human-building engagement in outdoor public space. The results of the visual attention simulation, structured e-survey and participative design indicate that:

- size, shape and arrangement of windows
- the interior-exterior transparency of the material
- the homogeneity in colour and texture
- maintenance of the building façades

are the most important indicators for visual attention and that visual coherence thereof is an important indicator of positive cognitive, emotional and physical awareness related to the Historical Extension, Collective Attached and Single Long Low-rise block and the likelihood of human-façade engagement.

This can be explained by the way the human brains scan and cognitively entangle visual cues as found in nature (Salingaros & Sussman, 2020). The Gestalt School of Psychology (Wagemans et al., 2012), as well as Christopher Alexander explain in their theory how visual patterns, such as proximity, similarity, symmetry, continuity affect human visual perception indirectly and how wholeness is correlated with coherent structure (Seamon, 2007).

Also, human attention towards the vertical axis in building façades can be illustrated by the fact that human vision is drawn from the gravity component of biophilia (Brielmann, et al., 2022). Even further, the biophilic healing index list revealed that representations of nature and organized complexity are major predictors of our wellbeing, indicating a positive effect of different natural and urban settings on the parasympathetic nervous system (Ulrich et al., 1991).

In this regard, within the context of Most Energy Vulnerable neighborhoods (MEV) in the city of Madrid, it is highly recommended to protect the symmetric and homogenous façades, as result of their special visual architectural interest for the city dweller. In case a building consists partly of a commercial floor, this design strategy is even more desirable to positively affect wellbeing of the viewer. When larger building blocks in deprived neighbourhoods do not perform a high diversity in façades, the use of vegetation in balconies result in positive cognitive, emotional and physical awareness, whereas window raster, air conditioning installation lower the human-façade engagement.

On the other hand, there are also some limitations related to this study. In view of the restricted inclusion criteria for participant's recruitment, this study cannot extrapolate the results to a population other than graduates/students with a background in architecture, urban design, or engineering. Therefore, prior knowledge in building design and human-building engagement in outdoor public space, might have affected the scoring of the e-survey and participatory design. Especially the participative design part might have been less challenging than non-designers would report. In addition to this, it might be interesting to further study a potential difference in male/female perception towards visual attention and subjective distress, something that is difficult to assess with a majority of female participants (7 out of 9) in this study. In the follow-up study a mixed participant group of female/male designers and non-designers will be invited.

Furthermore, this study cannot extrapolate the results of self-reporting measures (such as scored via Likert-scale and compiled via mind-body map) to all citizens in Madrid since the effect of engagement with building façades is based on subjective reporting and may therefore also have been influenced by personal preference or conditioning learning in the past, for example related to a negative experience in a poorly maintained built environment. This study is a preliminary study that defines and confirms the case study for a follow-up study where eye fixations/movements and galvanic skin response to urban materials will be evaluated in front of HE, CA, SL building façades with different window size/shape/alignment in Most Energy Vulnerable neighbourhoods of Madrid.

These analyses present the relevance of the three steps defined methodology as a crucial point for the following work. Indeed, although the visual attention simulation can detect the intensity of pre-attentive fixation spots, only through the structured e-survey and participative design it was possible to complete the analysis. This can be especially identified in HE and CA façades, where the overall evaluation reveals the grade of visual engagement completely different than in the simulated heatmap.



Thus, this preliminary paper will guide the follow-up study, both framed in the larger mateMad project that ultimately aims to optimize urban materials to make deprived neighbourhood more livable and sustainable.

## 6. Conclusion and future outlook

The objective of this article was to analyze visual attention towards building façades in deprived neighborhoods in Madrid and to examine the phenomenology of human-façade engagement to the end of creating beautiful, sustainable and inclusive neighborhood's. This study was framed in the larger mateMad project that aims to optimize urban materials to make deprived neighborhood more livable and sustainable. Innovative in this project is study of visual attention and human-façade engagement towards HE, CA, SL building façades with different window size/shape/alignment in Most Energy Vulnerable neighbourhoods of Madrid.

Unsustainable housing and social vulnerability of deprived neighbourhoods can have a cumulative negative mental health impact on local population groups. For this reason, photos of real building façades in 5 neighborhoods within representative Homogenous Urban Zones of Madrid were selected based on a deprivation assessment (notably those with the highest intensity of Urban Heat Island in summer and risk of Energy Poverty in winter).

Visual perception is a complex cognitive process although visual attention simulation software (3M VAS) made it possible to highlight non-obvious fixation points. Following the study of Salingaros and Sussman (2020), the pre-attentive visual attention towards HE, CA, SL building façades was simulated. Self-reported assessments were performed to explore conscious visual attention towards these building façades and to analyse its effect on the participant's subjective level of distress. In this case this was done via a structured e-survey and participatory design.

The results were that a lack of symmetry along the vertical axis and a-similar geometrical size of windows, poor maintenance, non-transparency of windows, and non-homogeneity in color and texture resulted in more reported subjective distress. Also, both the simulated as the self-reported fixation spots indicated that the horizontal/vertical symmetry and same size and shape of the windows resulted in cognitive entanglement and reduced subjective distress.

On the contrary, if a building lacked ordered structure, from the overall size of the building to the detailed consistency of the material, it was reported as being visually incoherent. This is to say, a lack of symmetry along the vertical axis and a-similar geometrical size of windows, poor maintenance (graffiti, ventilators) and non-transparency of windows (closed window shutters/closed balconies/window grid) and non-homogeneity in color and texture (concrete) resulted in cognitive disentanglement and more reported subjective distress. All of this can be explained by the fact that designs that do not include natural patterns ask for a longer neurological process because of information-processing constraints as result of visual complexity. This process may trigger additional arousal, whereas natural elements, such as plants on the balcony, may lead to reducing human distress.

To sum up, characteristics of the built environment impact on our emotions, behaviour and our mental well-being. For this reason, it is paramount to propose an urban renovation wave in Madrid's

deprived neighbourhoods in order to build resilient individuals and communities by means of beautiful, inclusive and sustainable housing.

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