





Patterns of (dis)agreement: revealing differences in perceived neighborhood boundaries in Lisbon

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Abstract. *The city of Lisbon is home to several traditional neighborhoods that depict the capital's history but face challenges arising from tourism and new population dynamics. Lacking administrative jurisdictions, their boundaries are perceived and defined differently among residents. By employing a participatory approach, we collect and analyzed residents' spatial perceptions of three symbolic neighborhoods - Alfama, Mouraria and Bairro Alto. Findings unveil different patterns of disagreement among participants, shedding light on potential mechanisms and factors that might influence their interactions with, and consequently, their perceptions of boundaries. Age, length of residence and residence proximity were the factors that caused the most distinguishable patterns between participant groups. This preliminary study seeks to contribute to both the broader research on neighborhood mapping and the understanding of residents' geographies that can ultimately guide local policy-making.*

Keywords. neighborhood; perceived boundaries; participatory mapping; urban geographies

1 Introduction

Neighborhoods are a fundamental socio-spatial unit, and yet one of the most intricate pieces of a city's ecosystem (Fontes and Cordeiro, 2023). Lisbon, a city with origins dating back to pre-historical times, exemplifies not only the richness of historic neighborhoods but also the challenges and pressure posed by processes such as touristification and gentrification, similar to other southern European cities (Sequera and Nofre, 2020; Estevens et al., 2023).

In Portugal, civil parishes are the official administrative sub-urban units in highly urbanized areas (Oliveira and Pinho, 2010). However, Lisbon is home of dozens of vernacular and historic neighborhoods that lie within or across administrative boundaries (Ramos, 1989; Krase and Shortell, 2011). The lack of clear boundaries stem from

different factors, including the evolution of the urban fabric, individual place-based representations at the "scale of the everyday", as well as the inherent vagueness that stems from regionalization (Montello et al., 2003; Tonkiss, 2013; Montello et al., 2014).

Delineating representative neighborhood units is essential in the design of spatial planning frameworks and operational definitions. Addressing social, economic and political issues at the urban scale requires the use of meaningful units, serving as the foundation for well-informed policies (Pang et al., 2024). Participatory mapping serves as a valuable exploratory approach in depicting how different population groups spatialize vernacular geographies (Montello et al., 2003; Deng, 2016; Tang and Painho, 2023).

This paper aims to explore the spatial arrangement of perceived neighborhood boundaries in Lisbon's historic core using methods of perception-based mapping. Our primary objectives are to extract, compare, quantify and visualize spatial consensus from different demographic profiles. Despite individual differences, people's experiences, lifestyles and interactions with the city create commonalities among similar groups based on variables such as age, length of residence and place of residence (Atkinson, 2015).

2 Study Area

Lisbon's urban landscape and fabric are a reflection of a rich and multi-layered history. The city hosts several *bairros*, a term that goes beyond "neighborhoods" as its translation (da Costa, 1999). *Bairros* are socio-spatial constructs that hold cultural, historical and social significance, being containers of community life, cultural manifestations, distinct architecture and social interactions (Fontes and Cordeiro, 2023). These neighborhoods have informal, vernacular or vague boundaries with different degrees of shared perception and recognition among residents (Ramos, 1989).

We focused on three emblematic neighborhoods in Lisbon that have been losing their identities, suffering from Lisbon's current housing crisis and witnessing challenges imposed by short-term rentals, gentrification and touristification (Daly et al., 2021; Jover and Cocola-Gant, 2023): Alfama, Mouraria and Bairro Alto. Alfama is one of Lisbon's oldest neighborhoods, where narrow Moorish style streets and alleys evoke Lisbon's foundational structure with currently more than a third of its real estate dedicated to tourist and short-term accommodation (Cocola-Gant and Gago, 2021; Fontes and Cordeiro, 2023).

Mouraria is a traditional multi-ethnic neighborhood that has received intense waves of immigration in the past 50 years and exhibits a dense social fabric (Tulumello and Allegretti, 2021; Malheiros et al., 2013). Lastly, a neighborhood characterized by its orthogonal fabric, Bairro Alto experienced decades of regeneration, becoming one of Lisbon's largest nightlife districts and eventually facing issues analogous to those in Alfama and Mouraria (Teixeira and Valla, 1999; Nofre et al., 2017).

3 Methods and data

3.1 Survey and pre-processing

We developed an online map-based survey¹ to collect participants' perceived boundaries. The base map contained the street network, green areas and building footprints. Labels were only present for streets and participants could freely pan as well as zoom in and out. Although we acknowledge the influence of the base map on responses, context and reference were indispensable for a tangible framework since a map lacking the street network would have hindered their ability to complete the task (M. Haffner and Perkins, 2022).

Since its implementation, we obtained 169 valid responses. Although the survey was openly available, respondents were not able to proceed if they stated that they had never lived in the city, an attempt to ensure that participants were current or previous residents. As participants were able to skip questions, the unprocessed dataset contained 493 geometries that comprised 195 polygons for Alfama, 153 polygons for Mouraria and 145 for Bairro Alto. In Figure 1, we display the distribution of drawn polygons for each neighborhood. Whereas Bairro Alto displays a higher agreement between participants, Mouraria and Alfama seem to share a fuzzy transition.

Based on the following criteria, we created categories to run the comparison between participant groups for each neighborhood:

- **Length of residence:** residents are able to enrich their cognitive maps over time and perceived boundaries might evolve (Finlay et al., 2023). We divided

¹<https://cityme.novaims.unl.pt/survey>

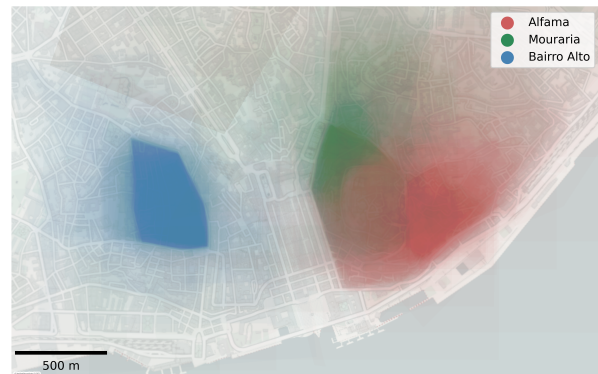


Figure 1. Study area and overlaid polygons with transparency for each neighborhood.

the respondents based on their length of residence in the city: **short-term** residents were living in Lisbon for < 10 years and **long-term** residents for > 10 years (Pánek et al., 2020).

- **Residence location:** dwellers whose home range are within or proximal to the neighborhoods are expected to contrast with ex-residents who had to rely on memory (Acedo and Johnson, 2020). **Nearby residents** were participants who lived in parishes of the historic core and **former residents** were those who had been residents in the city before but were not living in the city.
- **Age:** age might reflect the development of stronger place attachment and place interaction (Saadallah, 2020). **Younger** participants were aged 18-30, while **older** were ones over 30 years old.
- **Nationality:** native Portuguese participants, regardless of birthplace, grew up within the local cultural and linguistic context, potentially shaping their perceptions and place knowledge (Hernández et al., 2007). We split the participants into **Portuguese** and **non-Portuguese** groups.

Before analysis, we refined the polygon sets for each neighborhood and participant group by removing invalid geometries and outliers (Table 1). Outliers were identified by disregarding geometries whose centroids were too far, based on the 90th percentile of the nearest neighbor distances distribution within each dataset. Lastly, the polygon count for the residence location criteria does not add up to the original number of geometries for each neighborhood because of participants who were currently living in the city but not in close proximity to the neighborhoods.

3.2 Analysis

The diagram in Figure 2 illustrates the main steps and components of the analysis. Initially, we retrieved representative boundaries following the approach implemented

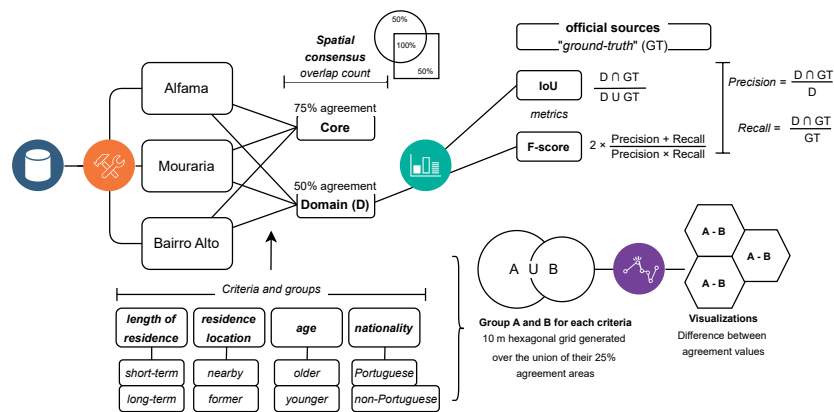


Figure 2. Diagram of the main components and steps of the analysis.

Table 1. Count of polygons used in the analysis for each neighborhood and participant group.

		Alfama	Mouraria	Bairro Alto
All		165	132	128
Length of residence	short-term	90	71	67
	long-term	75	62	61
Residence location	nearby	23	23	19
	former	34	25	21
Age	older	95	75	72
	younger	70	56	56
Nationality	Portuguese	102	78	82
	non-Portuguese	63	54	46

by Bae and Montello (2018). For each neighborhood and participant group, we computed the polygons' overlap counts, indicating the agreement among respondents. Subsequently, we extracted the boundaries using 50% and 75% agreement thresholds based on the overlap counts. These correspond to the core and domain regions respectively, two hierarchical levels of spatial consensus (Meinig, 1965).

To evaluate differences, our study areas corresponded to the union of the 25% agreement areas of each participant group within a given criterion and neighborhood. We then generated hexagonal grids with approximately 10 m sides and assigned each hexagon the overlap count and percentages for each group within a criterion.

Inspired by Pánek et al. (2020), we quantified disparities between groups based on the differences between the agreement values. Differences were calculated by subtracting values of one group from another. While higher or lower values indicate disagreement, values around 0 signals agreement between groups.

Although there are no civil parishes named after or tightly matching the neighborhoods, there are official sources that outline them in urban plans and heritage inventories. We assessed the spatial agreement between official definitions and the perceived neighborhood domains for each participant group (50% agreement).

To measure spatial concurrence, we calculated the intersection over union (IoU) as well as F-scores using the official sources as our "ground-truth". For Alfama and Mouraria, outlines were extracted from former urban rehabilitation plans². The boundaries for Bairro Alto were obtained from the Portuguese Cultural Heritage inventory³.

3.3 Data and Software Availability

We have made available the data and the scripts on Figshare⁴. The repository containing the survey and website source code are available on GitHub⁵.

4 Results and Discussion

Prior to evaluating differences, we computed the core and domain regions of each neighborhood for all participants (Figure 3). A higher spatial coincidence between its core and domain is seen in Bairro Alto, reflecting stronger consensus among residents. In contrast, Mouraria and Alfama exhibit lower agreements between their respective core and domains.

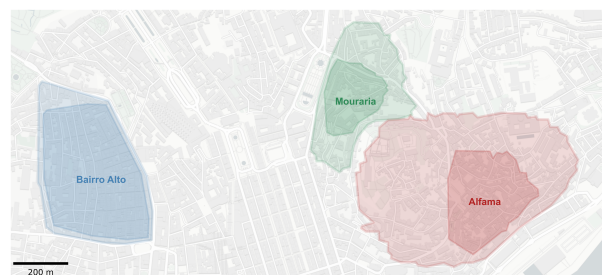


Figure 3. Core and domains of Bairro Alto, Mouraria and Alfama.

²<https://geodados-cml.hub.arcgis.com/>

³<https://www.patrimoniocultural.gov.pt/>

⁴<https://figshare.com/s/1d9a81fa37823d730076>

⁵<https://github.com/CityMe-project/CityMe-Web>

4.1 Alfama

Across all criteria, a disagreement pattern is noticeable in the southwestern portion of the study area (Figure 4). This area, adjacent to the flat downtown, aligns with the Castelo historic neighborhood, known for its medieval-like fabric and hilly terrain hosting the iconic São Jorge Castle (Sequera and Nofre, 2020). The pattern also seems to coincide with the valley that separates the Castelo neighborhood to the west from the eastern region which historically embeds the neighborhood's essence and idiosyncrasies (Cocola-Gant and Gago, 2021; Madeira et al., 2021).

Short-term, former, younger, and, to a lesser extent, Portuguese residents often included the Castelo region within their perceived boundaries. Hence, their counterparts - long-term, nearby and older residents - tend to align more closely with traditional spatial definitions of the neighborhood. Interestingly, this alignment was not as pronounced among Portuguese residents, suggesting the influence of time and proximity on boundary perception. Regardless, the criteria used to split groups revealed discernible patterns.

4.2 Mouraria

Differences between groups show more diverse patterns in Mouraria (Figure 5). The neighborhood's layout features narrow streets on two hillsides, opening up to large public spaces at the western boundary transition, such as Martim Moniz square and Almirante Reis avenue (Tulumello and Allegratti, 2021). This description fits particularly well with the perceptions of long-term and nearby residents. Curiously, older residents often associate the Castelo area as part of the neighborhood. While younger participants tend to identify the Castelo fabric as part of Alfama, older individuals commonly link it with Mouraria. In fact, the overlap transition zone between Alfama and Mouraria depicted in Figure 1 encompasses the Castelo hill.

Mouraria is one of Lisbon's most diverse historic neighborhoods, characterized by demographic, cultural and ethnic heterogeneity (Tulumello and Allegratti, 2021). Linked historically to immigrant populations and marginalized communities, the neighborhood's diversity is evident in participants' varied disagreement patterns across criteria. The varied patterns of disagreements might have emerged due to different groups experiencing different "niches" of the neighborhood.

4.3 Bairro Alto

The prominent orthogonal fabric of Bairro Alto likely contributes to a higher spatial agreement among all participants (Tang and Painho, 2023). Nonetheless, a discernible trend is evident when examining its eastern boundary where stronger disagreement is present among short-term, younger and former residents, possibly due to the disruption of the fabric due to topographic changes (Figure 6).

Conversely, long-term, nearby and older residents more frequently perceive western areas as part of neighborhood, characterized by smoother transitions towards adjacent neighborhoods and minimal topographic disruption. Prolonged exposure may have contributed to heightened perceptual acuity in discerning urban fabric.

Age differences in Bairro Alto exemplify how affordances might have influenced perceptions of its extent. Younger adults and former residents, potentially including international students, often incorporate densely populated areas with bars and clubs, reflecting the neighborhood's status as a nightlife district (Pablo Martí and Baeza, 2022).

4.4 Official sources

In Figure 7, we present the official delineations together with the perceived neighborhoods' cores and domains. While we acknowledge the absence of a definitive "ground-truth", our goal was to juxtapose perceived boundaries with delineations established from the top down. These delineations partially rely on components such as the urban fabric, architecture and historical features.

Bairro Alto shows a significant similarity between its domain and the boundaries established by the cultural heritage inventory. In Mouraria, perceptions are somewhat similar in shape to the official source, though with notable differences in the northern portion according to the rehabilitation plan. Alfama's plan is named after Castelo and Alfama. Consequently, the alignment of its domain with the official source is caused by residents who perceive Castelo as part of the neighborhood.

To compare each demographic profile's perceived domain with the official extents, we present the IoU and F-score results in Table 2 and 3. Bairro Alto yielded higher values across all groups, confirming the visual output and indicating a higher consensus among residents on identifying a cohesive neighborhood unit.

Table 2. Intersection over union between neighborhood domains and official delineations.

	IoU (Domain vs. Official Sources)		
	Alfama	Mouraria	Bairro Alto
All participants	0.66	0.41	0.93
Short-term	0.63	0.37	0.92
Long-term	0.59	0.42	0.91
Nearby	0.45	0.33	0.92
Former	0.64	0.26	0.84
Younger	0.63	0.30	0.91
Older	0.59	0.47	0.91
Portuguese	0.62	0.39	0.92
Non-Portuguese	0.59	0.40	0.89

Contrasting patterns in Alfama are heavily influenced by the disagreement among participants regarding the Castelo hill. IoU and F-score results favor short-term, former, and

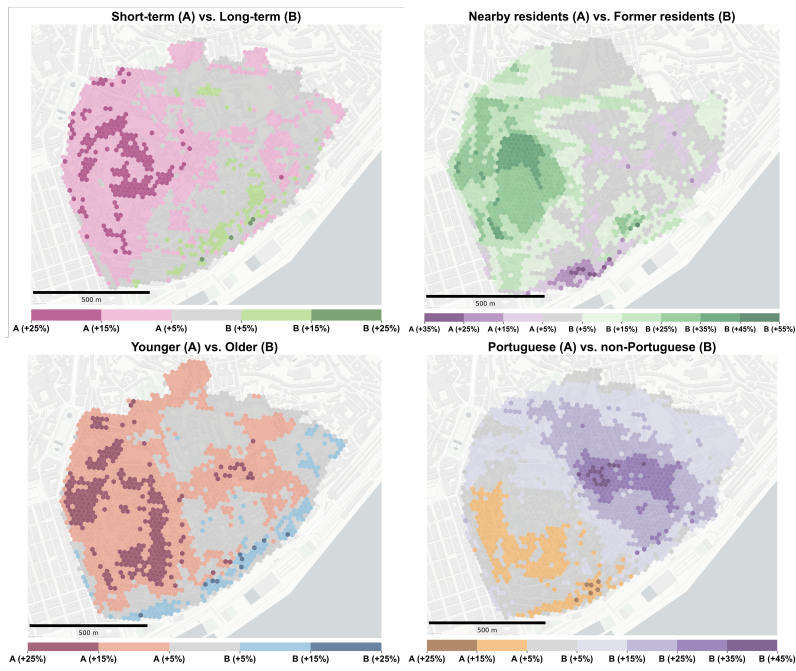


Figure 4. Relative differences between participant groups of Alfama’s perceived extents for each criterion.

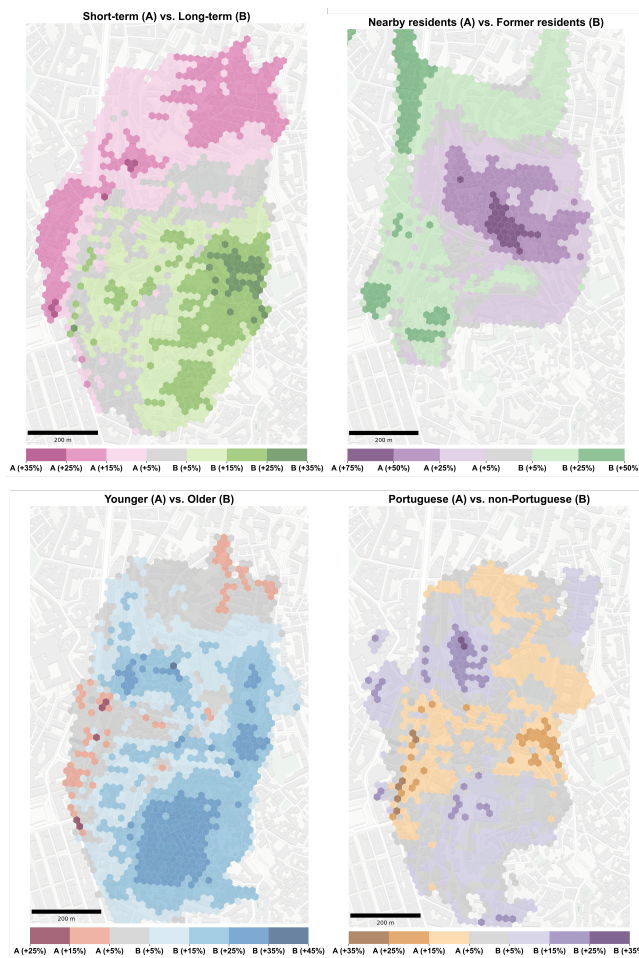


Figure 5. Relative differences between participant groups of Mouraria’s perceived extents for each criterion.

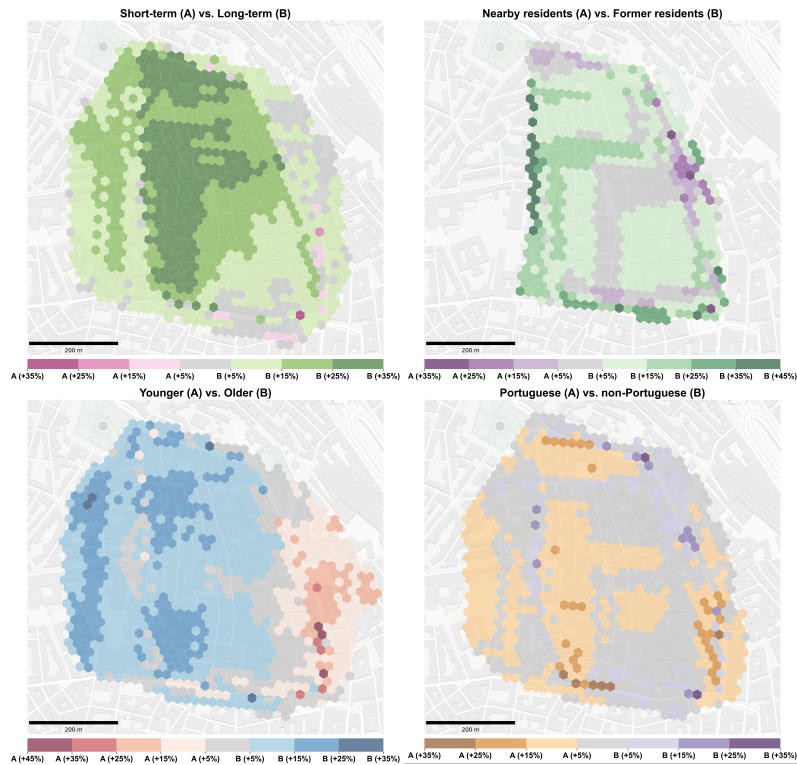


Figure 6. Relative differences between participant groups of Bairro Alto's perceived extents for each criterion.

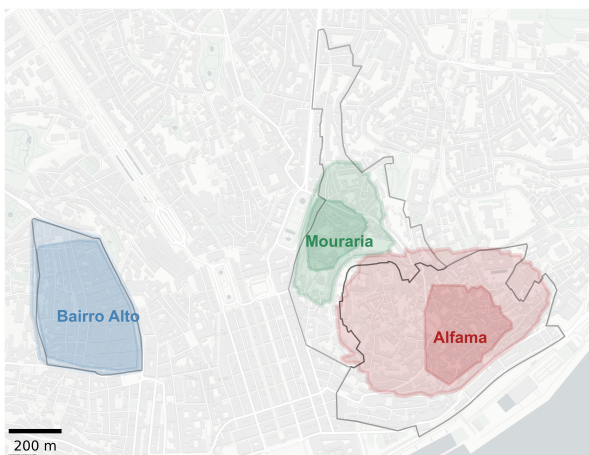


Figure 7. Neighborhoods' cores and domains juxtaposed with official delineations.

younger participants, who often include Castelo in line with the urban rehabilitation plan. Nearby residents, who often included the traditional core of Alfama, recorded the lowest IoU score. Overall, disagreement patterns neutralize when considering all participants, yielding the highest F-score value.

In Mouraria, the domains of long-term, nearby and older resident groups yielded higher values than other groups. Despite the generally low values for all groups, likely due to the plan covering non-traditional areas, the highest IoU and F-score values were observed among older resi-

Table 3. F-score of neighborhood domains against official delineations.

	F-score (Domain vs. Official Sources)		
	Alfama	Mouraria	Bairro Alto
All participants	0.80	0.58	0.96
Short-term	0.77	0.54	0.96
Long-term	0.74	0.60	0.95
Nearby	0.61	0.50	0.96
Former	0.78	0.41	0.91
Younger	0.78	0.46	0.96
Older	0.73	0.64	0.95
Portuguese	0.77	0.56	0.96
Non-Portuguese	0.74	0.58	0.94

dents. Seemingly, perceptions from older participants bear a stronger resemblance to the official delineation design.

5 Conclusions and Future Work

Traditional neighborhoods of Lisbon are facing both positive and negative aspects of a changing population and evolving cityscape (Fontes and Cordeiro, 2023). Through extracting perceived boundaries based on spatial consensus, we showcased some of the diversity in residents' geographies of historical urban areas. Most criteria yielded noteworthy distinctions that emphasize the role of time and proximity in shaping the imageability of those neighborhoods. The case of Alfama and the adjacent Castelo

neighborhood illustrates how these factors refine residents' spatial representations.

The results highlight patterns of (dis)agreement among participant groups when defining neighborhoods lacking administrative boundaries, which in turn can be the starting point for specific census tract aggregations aimed at a particular research question or policy (Campbell et al., 2009; Estevens et al., 2023). In addition, the bottom-up mapping of perceived boundaries and analysis of patterns could be an important step in informing planning efforts and policy decisions (Pang et al., 2024).

Limitations include potential bias towards certain demographics as well as an undefined degree of overlap and arbitrariness in splitting participants. Moreover, responses mostly exemplify exogenous spatial definitions and do not exclusively reflect the cognitive representations of those who live and are deeply rooted in the neighborhoods. Nonetheless, future avenues should consider other demographic variables that influence urban residents' experiences and hence perceptions, such as income and race. Additionally, a natural extension of this work is to incorporate information about places, points of interest and landmarks into the theoretical and methodological framework to enrich our understanding of perceived boundary patterns.

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Competing interests. The authors declare that there are no competing interests.

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