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The scales of the metropolis: Exploring cognitive maps using a qualitative approach based on SoftGIS software

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ABSTRACT

The spatial dimension of daily mobility depends on where people choose to perform their daily activities in urban environments. This study explores the influence of multiple geographical scales, characterising metropolitan regions on the cognitive images of individuals, whose daily mobility is restricted by an interurban daily commute to a university campus in the Metropolitan Region of Barcelona.

To do so, a sample of 28 adults from the Barcelona Metropolitan Region (RMB) were asked to describe perceived activity spaces using a combination of SoftGIS technology and interviews. Results have shown that different individuals can perceive the same geographic context in several manners, differentiating their utilised space between spatial continuums, fragmented territories or overlaid territories. Furthermore, factors such as the different spatial scales that affect a territory, the morphological characteristics of residential areas or the transport infrastructures, have proven to influence cognitive maps of individuals. Finally, different methods utilised for the exploration of cognitive maps have provided variations in the resulting cognitive images of participants.

1. Introduction

The spatial scale at which everyday activities are located determines the daily travel costs for residents of metropolitan regions and the consequent transport-related externalities (Banister, 2008; Ewing et al., 2016). Therefore, understanding the determinants affecting the spatial behaviour of metropolitan residents is essential for urban policymakers when tackling these externalities (Buliung and Kanaroglou, 2006).

As well as the environmental setting and the sociodemographic characteristics (Fan and Khattak, 2008), the structure of the extent of daily mobility of individuals, or *activity space* (Horton and Reynolds, 1971) is influenced by an individual's cognitive image of the real world (Downs and Stea, 1973). According to psychological and urban studies, the information required to understand where things are and how to get to where those things are is stored in the cognitive map of individuals, hence, becoming essential for spatial behaviour and decision-making (Gärling, 1989). In consequence, such decisions and behaviour have an effect on where to carry out daily activities, and the routes and the mode of transport to be utilised between destinations (Kitchin, 1994).

This study explores the influence of multiple geographical scales in metropolitan regions on the cognitive images of individuals. For this purpose, SoftGIS mapping exercises and interviews were used to obtain the cognitive maps of the territory utilised by a sample of 28 adults, whose daily mobility is constrained by an interurban daily trip to a university campus in the Barcelona Metropolitan Region (RMB).

This paper is structured as follows: Section 2 delves into the theoretical aspects of the concept of activity space and its explanatory factors, such as cognitive images. Section 3 contextualises the campus of the Autonomous University of Barcelona (UAB) within the RMB and the utilised methods and data for the analysis. Section 4 presents the resulting qualitative analysis. In Section 5, the main results are contextualised with past studies. Section 6 concludes and outlines future lines of research in this field.

2. Background

Dispersion, integration and specialisation are spatial dynamics that characterise metropolitan regions and imply increased travel distances and times (Banister, 2008). However, these have been complemented by other urban dynamics such as urban proximity, which relates to the use of the immediate urban environment by residents in order to meet daily needs (Calonge Reillo, 2017; Mateu et al., 2017; Schmid et al.,

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2011). These dynamics are characterised by the agglomeration of activities and the intensive use of space, while facilitating human interaction, economic efficiency and social cohesion (Huriot, 1998), requiring certain morphological features such as urban compactness and density (Miralles-Guasch and Marquet, 2013). Thus, the recognition of this duality of urban dynamics (expansion and proximity) evidences the coexistence of different relational layers at a particular place of interaction in urban contexts (Massey, 1994), and the multiscale character of urban areas by linking the neighbourhood, the city and the metropolitan region (Atkinson et al., 2009).

Consequently, these spatial dynamics influence the utilised space by metropolitan residents in their everyday life. This daily space, also known as *activity space*, is structured by the locations with which people have direct contact on a daily basis (Horton and Reynolds, 1971) and has been a generally accepted measure of the geographic extent of the daily mobility of individuals (Gesler and Meade, 1988; Vich et al., 2017). However, the environmental factors influencing the extent of everyday life alone, such as physical distances between activities, might not fully explain spatial behaviour.

The anisotropic character of actual urban spaces means that spatial distances can be shaped by the combination of both objective and subjective factors, making perceptions, beliefs and preferences important determinants of spatial behaviour (Dumolard, 2011). For this reason, the built environment also acquires certain subjective qualities due to the perceptions of individuals related to, for example, what may be physically reachable (Horton and Reynolds, 1971). The mental configuration of the environment is the psychological process *"by which an individual acquires, codes, stores, recalls and decodes information about the relative locations and attributes of phenomena in his everyday spatial environment"* (Downs and Stea, 1973, p. 8), and can be represented through cognitive (or mental) maps.

This visual representation of cognitive structures is believed to internally delimit the external borders of people's activity space in their own minds (Greenberg Raanan and Shoval, 2014) and, therefore, influence spatial decisions of individuals over both the short and long term (Gärling, 1989; Golledge and Stimson, 1987; Lynch, 1960). Decisions on where to reside or work, and the locations, destinations for recreational activities, and how to travel between destinations also depend on the cognitive images of the surrounding environment of the individual (Downs and Stea, 1977). In an urban context, these spatial decisions may represent consequences for the territory, such as rising levels of energy consumption, air pollution and increasing investment in transport infrastructure, and loss of agricultural land and open space (Ewing et al., 2016).

The study of cognitive mapping within behavioural geography reached its heyday in the 1960s and 1970s. One of the main focal points was the exploration of how individuals built and organised spatial information in their own minds, in other words, how these mental structures evolve through learning (Downs and Stea, 1973). Cognitive maps were also used to understand the nature of preferential cognition with regards to the environment, with special mention to the work of Peter Gould and Rodney White in *Mental Maps* (1986, p. 15). Finally, a very successful body of research, in which the present study falls, analyses the processes of cognition of urban environments or urban imagery, with the remarkable contribution by Kevin Lynch (1960) of *The Image of the City*, highlighting the five elements forming cognitive spatial structures, which was later followed by Donald Appleyard (1970): pathways (streets, roads, trails…) along which people travel, edges or boundaries (walls, buildings, and shorelines), districts/neighbourhoods, meaning relatively large areas within cities with particular identity, focal points such as nodes and, finally, landmarks or identifiable objects serving as reference points.

In the late 1970s, the study of cognitive maps and environmental cognition was relegated to the field of geography due to the dominance of radical and humanistic approaches that considered such research as conceptually and methodologically flawed. Common criticism included the omission of economic and social conditions of individuals (Rieser, 1973) and their precognitive background emanating from the history, art, literature or religion, with which to understand people's behaviour (Tuan, 1976). In terms of methodology, methods often utilised in those days, such as ranking procedures or the sketching of cartographic maps, were regarded as being highly dependent on abilities to draw maps and upon education, hence, resulting in imperfect representations of spatial cognition (Blaut et al., 1970).

After years of relegation within geography, a rekindled interest for cognitive and behavioural methodologies, such as cognitive maps, has emerged due to two main reasons. Firstly, the combination of sociodemographic characteristics of the population (age, gender, etc.) with psychological processes to understand human behaviour, instead of solely focusing on the latter, is gaining acceptance in geography. The use and perception of large-scale environments by particular sociodemographic groups through their cognitive boundaries is now a common field of study (Argent, 2017; Walmsley and Lewis, 1993). An example of that would be to understand how children, seniors or women perceive and represent their residential neighbourhood. Recent evidence shows that cognitive boundaries and used spaces do not coincide with administrative limits of neighbourhoods, census tracts or residential buffers, hence, they prove to be more accurate representations of their geographic scale of their everyday life (Robinson and Oreskovic, 2013; Smith et al., 2010; Stewart et al., 2017; Veitch et al., 2008). This coincidence between perceived and used territories is also confirmed by Greenberg Raanan and Shoval (2014) who explore the cognitive maps and GPS tracks of adult women in the highly segregated city of Jerusalem. Another area of study that takes into account cognitive processes influencing human behaviour is transport and urban planning (Arentze and Timmermans, 2005; Gehrke and Clifton, 2015). In this line, Mondschein et al. (2010) and Minaei (2014) analysed the differences in mental representations of the cities of Los Angeles (USA) and London (UK) by commuters travelling using different transport modes. Although some classic research from the 1970s already analysed the legibility and desirability of predefined administrative limits of metropolitan regions through cognitive maps (Johnston, 1972; Pacione, 1977), no recent examples could be found which explore the cognitive representation of the experienced activity spaces and the influence of geographic scales in metropolitan regions.

Secondly, the development of sophisticated quantitative methodologies and the appearance of new technologies, such as Geographical Information Systems (GIS), also helped to maintain the interest in cognitive mapping (Gold, 2009). Furthermore, a geography-based approach in focusing on cognitive behaviour of particular groups within a population, such as children or the elderly, continued being active and also continued yielding vast amounts of research. Issues such as the development of environmental cognition and its pedagogic implications, the usage of territories and facilities, spatial preferences and perceptual constraints, among others, are still being studied and applied in policymaking (Argent, 2017). Advances in technology have also played a key role in allowing to collect, standardise and process large amounts of geographic information. Within GIS-derived applications, SoftGIS can be highlighted as containing useful tools for obtaining cognitive maps of individuals. Interactive on-line mapping applications, such as Google Maps© and Open Street Maps, allow the collection of spatial knowledge such as locations, routes and the delimitation of areas, while minimising memory bias (Chaix et al., 2012; Jarvis et al., 2017), and are normally included in surveys or interviews (Rantanen and Kahila, 2009). Whether used on computers, tablets or smartphones, these mapping applications are becoming a common tool of daily use among young people for wayfinding, since they provide 'up-to-date', scalable, 'more easily accessible' spatial information, standardising the drawing abilities of participants and, in consequence, they minimise the use of paper maps for research purposes (Leyshon et al., 2013). Existing studies have implemented this technique to explore, for instance, the barriers and facilitators of active transport among children (Broberg