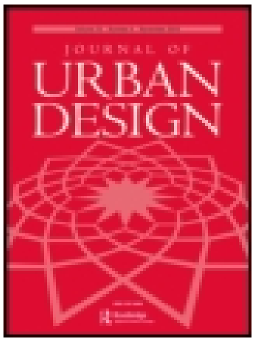


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# Aesthetical cognitive perceptions of urban street form. Pedestrian preferences towards straight or curvy route shapes

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**ABSTRACT**

Human perception of space is not purely metric. Route angularity and complexity-minimizing paths suggest that pedestrians, consciously or not, tend to reduce the number and the angle of turns when selecting routes. Decisions involving route selection are different when the main criterion is not the orientation but the aesthetics of urban forms. This paper indicates that 80% of a stratified random sample of 102 people stated to prefer, *ceteris paribus* and for continuous/legible routes, to walk throughout curvy paths instead of straight and felt the former as shorter too, to generically walk through a route, and to reach a destination.

## Introduction

Comprehension and prediction of pedestrian walking trajectories and preferences is attracting the attention of scholars from multiple sectors. Despite the relatively large multidisciplinary literature that is increasing on the topic, the interrelationship between walking trajectories chosen and the pedestrian's perception of the environmental design attributes is often neglected (Nasir et al. 2014). Lee et al. (2014) noted that previous studies have lacked focus related to whether, and how, street structure affects pedestrians' path choice. Understanding pedestrian preferences on street forms to walk through is beneficial for urban design generating pleasant and psychologically comfortable urban environments. From an environmental point of view, promoting sustainable travel behaviour is a key objective to achieve a substantial reduction in $CO^2$ emissions from transportation (EC 2011). Walking is a key strategic transportation mode within cities which provides health benefits, social capital, relieves traffic congestion, preserves resources and vitalizes communities (Leyden 2003; Blanco et al. 2009). To motivate citizens to walk, it is necessary to take into account the urban environmental factors influencing their satisfaction of walking which form a polyhedric matrix of variables touching a variety of disciplines such as urban planning, architecture, environmental psychology, transport planning, sociology and geography.

Factors influencing walking behaviour are separated into two macro categories: interaction with the environment and interaction with other users. Four sub-categories define the interaction with the environment: pedestrian network; pedestrian environment; infrastructure provision-management; land use and urban form. Two sub-

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categories define the interaction with other users: interaction with other pedestrians and interaction with traffic (Hodgson, Page, and Tight 2004). Wang et al. (2016) offer a vast recent literature review of physical built environmental attributes enhancing walking; focusing on the first of the above two macro categories, scholars have described built environmental characteristics influencing individuals' walking behaviour, including land use form (Frank et al. 2005); street connectivity (Owen et al. 2007; Shigematsu et al. 2009); aesthetic appearance of the surrounding environment and pleasantness of sceneries (Giles-Corti and Donovan 2002; Owen et al. 2004; McCormack et al. 2004; Inoue et al. 2010; Van Dyck et al. 2013); city sprawl (Lopez and Hynes 2006) and unpleasant vistas (King et al. 2000; Ball et al. 2001). In addition, Ferrer López, Ruiz Sánchez, and Mars (2015, Appendix A) provide an extensive organized list of built environmental factors associated with walking and their positive or negative effects on walking. Camillo Sitte's (1889/1986) *City Planning according to Artistic Principles* was followed by other masterpieces of literature unfolding qualities that urban areas should have to be pleasant and prosperous (Jacobs 1961; Alexander 1965; Bacon 1967; Lynch 1981; Appleyard, Gerson, and Lintell 1982; Anderson 1986; Alexander et al. 1987; Jacobs and Appleyard 1987; Southworth 2003; Hillier 2007), and, more specifically, relations between urban design and perceptions of a moving person were underlined since Cullen's work in the second half of last century (Cullen 1971). Since then an extensive modelling apparatus explained and simulated moving person trajectories (Papadimitriou, Yannis, and Golias 2009), in which route choice, navigation, path finding and crossing intersections are the most common behaviours investigated (Xi and Son 2012).

There are mainly three microscopic modelling approaches: the social force model (Helbing 1991), the cellular automata and the agent-based model (Terna 2015; Wilensky and Rand 2015). The social force model is a continuous deterministic approach based on socio-psychological forces treating the surrounding environment as an attractive and repulsive magnet for pedestrians' trajectory. The cellular automata is a discrete deterministic-stochastic approach translating the urban surface into a grid of equal cells having certain attributes which, according to a transition matrix providing pedestrians' rule-preferences, determines how pedestrians move from one cell to the adjacent based of these attributes. The relatively more recent agent-based models, contrarily to the cellular automata and the social force models, are heterogeneous in nature; they are able to model a multitude of different agents (pedestrians) characteristics-preferences by a multi set of if-then rules capturing a large variety (technically infinite) of pedestrian profiles. In all the above model approaches, and at whatever macro, meso, micro level, it is critical to know how to build equations, codes and rules computing pedestrian street choice and walking behaviours.

Within the many factors influencing pedestrian street choice, this paper analyzes the effects of the shape of streets on pedestrian preference. Besides modelling applications, this paper is also relevant to urban design and planning: new cities are appearing, growing and/or transforming; in an urban world which is trying to (re)create the human sense of *urbanity*, it is pertinent to know which urban form makes people feel more comfortable. The shape of streets is a constituent of urban form and knowing which street shape pedestrians prefer, specifically between straight lines or sinuous, is very timely in an epoch of post-mega grid urban forms initiated in recent centuries by Pugin (1836), Ruskin (1849), Morris (1891) and Sitte (1945). While the orthogonal street grid of the Harappian, Egyptian and Greek gridiron town layout, the Roman Centuriation and the Chinese Zhou modular urban geometry of the ancient cities were covering grids of a few hundred metres a side, urban grids such as European American colonies or the Barcelona of Cerda, extend for tens of kilometres and are made less friendly to pedestrians because of the mega blocks pattern: this scale difference is the determinant for the perception of a human environment.

From a wider angle, different approaches explore factors potentially influencing landscape preferences:

> the evolution theory, for example, argues that based on a common evolutionary background, there is a common preference or aversion for landscape features based on innate, biological reasons; see, for example, the prospect-refuge theory (Appleton 1975) or the information processing theory (Kaplan & Kaplan, 1989) [or from an even wider angle see also Wilson (1984, 2004)]. Other theories highlight that landscape perception and preferences are shaped by learned behaviour and people's cultural background (Zube, Sell, and Taylor 1982). It is most likely that both evolutionary and cultural background shape landscape preferences (Arnberger and Eder 2011; Tveit, Ode, and Fry 2006). (Häfner et al. 2018, 847)

## Perceptions of street shapes

Agrawal, Schlossberg, and Irvin (2008) found that only 21% of a sample of 328 respondents rated as 'Not important' the aesthetic elements of the build environment in influencing their route choice, while for the rest 79% is 'Very important' or 'Somewhat important'. The British-Canadian psychologist and philosopher Berlyne (1974) was one of the first in formalizing beauty with a general model of aesthetics based on four components of an environment: complexity, novelty, incongruity and surprise. He also suggests an inverted-U relation linking 'hedonic tone' (pleasantness) with 'uncertainty-arousal' (stimulations, explorations): as uncertainty increases, hedonic level also increases, but after a certain point decreases. The 'happiest' feeling, or most pleasant appreciation of a scene, is for an intermediate level of visual stimulations, not too low neither too high.

Qualitatively similar results somehow close to the Berlyne inverted-U, came from fractal studies (Hagerhall, Purcell, and Taylor 2004; Taylor et al. 2011) about landscape views, where the latter are quantified by the fractal dimension (the higher the more intriguing, detailed, rough, visually complex, irregular the scene is), and the highest level of preference is for medium values of the fractal dimension range of the visual scenes: neither too simple nor too complicated. Processes involved in the perception of space relate to environmental psychology and spatial cognition. Bell, Fisher and Loonis (1978, 6) defined environmental psychology as 'the study of the interrelationship between behavior and the built and natural environment'. It is a psychology of space analyzing individual perceptions, attitudes and behaviours in relation to their environment. Its conceptual framework was established in the nineteenth century until consolidating its own area of research in the 1960s.

> Rather than a specific branch or specialized sub-discipline of psychology, environmental psychology is an interdisciplinary social science which draws from geography, anthropology, sociology, public policy, education, architecture, landscape architecture, urban

> planning, education, and psychology, especially social and developmental psychology (Gieseking 2014, 587).

Spatial cognition gives noteworthy inputs to the studies of urban layout geometries and synergistically links disciplines such as environment psychology, urban design and spatial analysis; it is the study of perceptions, thinking and reasoning about spatial properties. Starting with Lynch (1960) in architecture and urban environment, Lowntahal (1961) in geography, Trowbridge (1913) and Tolman (1948) in cognitive psychology and science, spatial cognition indicates that there is a difference, sometimes substantial, between physical space and mental space.

Studies in spatial cognition (Stevens and Coupe 1978; Egenhofer and Mark 1995; Mark, Smith, and Tversky 1999; Kitchin and Blades 2002; Tversky 2003; Montello and Freundschuh 2005) show how the physical space and the one we perceived differ: 'spatial knowledge is not veridical with physical space but is distorted *systemically*' (Rashid 2017, 22). This human cognitive spatial distortion is not because of some mind-brain glitches but is how our minds systemically work (Portugali 2011).

Parts of these distortions refer to evaluating geometries, first starting with topology and only second adjusting with metrics instead of the other way round, or, of only metric assessments (Piaget and Inhelder 1956; Kuipers 1978; Montello 1992). 'Human thinking and perception of spaces are not simply metric' (Blanchard and Volchenkov 2009, 22); scholars agree that spaces are psychologically translated.

Dalton (2003, 107) shows that people 'appear to be attempting to conserve linearity throughout their journey … choosing the straightest possible routes as opposed to the more meandering routes. This particularly significant result supports hypotheses made by Hillier (1997) in which he stated that people tend to follow the longest line of sight that approximates their heading'. As a justification of it, Dalton recalls Tolman (1938), Sadalla and Montello (1989), Montello (1991), and indirectly also Miller (1956), concerning human memory and complexity: keeping the straightest route, deviating as little as possible, reduces complexity; people may unconsciously prefer a straight path as a complexity-minimizing strategy (Dalton 2003).

However, an essential point here is how much a person knows the area in which they are navigating (i.e., walking or cycling). If we are talking about citizens walking in their own city, or in neighbourhoods that they know well (as usually is the case for residents) we may wonder if we should pay attention to the above complexity-minimizing strategy or if we can just focus on what type of paths they actually prefer and feel more comfortable to walk through. They probably would not be worried about getting lost, or forgetting how many times they should turn to reach the destination, or getting disorientated because of turning many times; we assume that residents know their own streets and places very well and do not need to memorize how many changes of direction they did or should do; they know these streets by heart.

Another point deserving attention is if a person (regardless of their knowledge of the area) walks along a street without intersections or ramifications into other streets. In this case they cannot get lost anyway because there is only one path to follow, no matter its geometry (straight or sinuous). This is also the case of a street which even if it intersects other streets (or ramificates into other streets), it holds a strong identity and a clear continuity (i.e., because of the relative size, or aesthetics, contents, name etc.); namely, a street which is very easily recognized as being *the same street* even if not geometrically linear and/or even if crossing many streets at various angles.

Apart from this, Dalton did not ask her 30 participants at her virtual street environment test 'which route would you *prefer* to go from x to y', but 'were instructed to walk … by the *most direct* route possible' (Dalton 2003, 108); what was asked was the *most direct* route possible so we should not be surprised about the results.

Scholars supporting the least angle change route also refer to the *route angularity* cited in Tolman (1938), Sadalla and Montello (1989), Montello (1991), as the 'phenomenon of judging a route that contains many changes of direction to be longer than a straighter route of identical length' (Dalton 2003, 126). Garling and Garling (1988) pointed out that 'path minimization [in terms of time or distance] may not be adopted by pedestrians in all settings', however, it 'is a dominant characteristic of the observable routine movement within a city […] minor changes in direction tend to be preferred over great changes in direction, perhaps because of an innate human tendency to avoid getting lost' (Zacharias 2001, 10).

Nevertheless, when analyzing these observations of real people's movements, we should reflect about who the subjects are (citizens knowing their own areas very well, or not, and investigating further if this happens also for the former), what their movement purpose is and what the content and context of the streets are (high buildings, shops, empty spaces, noisy, dirty, elegant etc.).

Montello (1991) also found that people are more comfortable in orienting in straight route patterns. He asked 60 pedestrians who were stopped in a neighbourhood to indicate the locations of several targets not visible from their own position.

> Results demonstrate that environmental orientation depends in part on the angularity of route structure, the disorienting effect of oblique routes being due to memory distortion or imprecision associated with oblique routes […] as hypothesized, subjects generally pointed with greater accuracy when standing on the orthogonal street […] than when standing on […] oblique street (Montello 1991, 47, 63).

The *orientation* was tested but not the *preference*.

This does not necessarily mean that to go from x to y people would prefer the straight path instead of an oblique one because they would orient themselves better; if they are not worried about getting lost (because they know the area well, or because they want to randomly explore the area, or because there are enough indications [street names, panels etc.), they may simply follow the path that makes them more comfortable.

There are therefore two orders of analysis: one related to the *physical* street patterns analysis (*geometrically* oriented); one 'adds' *attractions* to the latter (*geographically* oriented). *Space Syntax* (Hillier and Hanson 1984) is part of the first family, while *Place Syntax* (Ståhle, Marcus, and Karlström 2008), of the second. Within the latter, *Isobenefit Lines* (D'Acci 2015) are an example in which *Psycho-economical distances* are proposed to compute 'not just how fast, or cheap, or mentally easier it is to move among locations, but also how pleasant it is: you may choose one path instead of another not just because it is faster, cheaper or mentally easier, but because you like it more … even if a route is longer, it may be more pleasant and therefore one might prefer it rather than a shorter but less pleasant one' (D'Acci 2015, 65).

The comfort depends on several factors such as noise, aesthetics, sun/shadow, quietness/crowdedness, land use and so on. One of these factors is the *shape of the path* itself; the two research questions this paper wants to reply to/confirm, and to open a profitable discussion within the scientific community of Space Syntax are:

(1) Keeping everything else constant, do pedestrians prefer a straight path rather than a sinuous one?
(2) Do they feel it is shorter too?

Regarding the first research question, Kent (1989), Matsumoto, Koyanagi, and Seta (1997) and Herzog and Miller (1998) in line with Kaplan's dimension of mystery of his environmental preference theory (1987, 1988), pointed out that a spatial layout concealing exits and the space immediately out of view, such as curved streets, stimulates curiosity and therefore guides preferences. According to the Kaplans, 'we like scenes that are engaging and involving – scenes that contain some mystery [...] Typical examples of scenes with high mystery are those featuring paths curving out of sight' (Bell et al. 2001, 43, 46).

This was confirmed from Ewing and Handy (2009), who found that long sight lines are negatively correlated to the urban design qualities creating comfortable and pleasant feelings such as enclosure and human scale (Ewing and Handy 2009, 72, tab 2):

> the layout of the street network can influence the sense of enclosure. A rectilinear grid with continuous streets creates long sight lines. These may undermine the sense of enclosure created by the buildings and trees that line the street. Irregular grids may create visual termination points that help to enclose a space [...] The sign of the coefficients in the model are as expected, with long sight lines [...] detracting from the perception of enclosure [...] [and] detract from the perception of human scale. (Ewing and Handy 2009, 74, 76, 78)

Zacharias states that the expectation of spatial new information just beyond the angle of vision is a 'positive inducement to exploration' (Zacharias 2001, 342), and more generally, a certain level of spatial complexity is an important element to create stimulating human environments.

Finally, another relevant consideration to take into account in these types of analysis is the separation between *exploratory* behaviour and *goal-directed* behaviour (Zacharias 2001), and those between *understanding* and *exploration* of Kaplan (1987). Similarly to Berlyne's model, Kaplan's model organizes the preference matrix into four components: coherence, legibility, complexity and mystery. The first two relate to understanding (comprehend the environment), the last two relate to involvement, exploration (stimulation, motivation).

Regarding the second research question, we partially[1] enter into the domain of scaling in spatial cognition. 'Scaling refers to a large and diverse set of explicit-report techniques in which respondents directly express their beliefs about quantitative properties of the environment [...] Quantitative means that properties are not just classified but rated or estimated at a metric level of measurement – interval or ratio' (Montello 2016). There are two main methodological traditions: psychophysics (from the 1800s) and psychometrics (from the beginning of the 1900s). Psychophysics respondents assess quantities of certain properties that can be later compared by the researcher with the real quantities *objectively* measurable (Gescheider 1997). Psychometric refers to properties *not objectively* measurable (e.g., preferences, personality traits, etc.) (Boorsboom 2005).

Jansen-Osmann and Wiedenbauer (2004) used a psychophysical scaling method[2] to 'explore the "route-angularity effect" in spatial cognition, in which people think routes with more turns are longer than routes with fewer turns but of the same actual length (in fact, this and other research studies found the effect to be inconsistent, not found reliably)' (Montello 2016).

Figures 1 and 2 show a few examples of straight and curvy streets.

## Street shape preferences from pedestrians: the questionnaire

Four images (Figures 3–6) with two street scenarios each (A, B) were given to a sample of 102 respondents: 47.1% female, 52.95% male; 60.8% between 21 and 40 years old, 33.3% between 41 and 70, 3.9% older than 70, 2% younger than 20; 71.6% from Western Europe, 12.7% from South and Central America, 8.8% from Asia, 3.9% from Eastern Europe, 2% from Africa, 1% from North America and Australia.

After underlining to imagine that both streets (A, B) are perfectly safe in the same way, they were asked 'In which street do you prefer to walk?' The options were A, B or Indifferent. An additional open question also asked 'why?' for each case.

The survey was conducted face-to-face (82) and online[3] (20), by providing figures and questions on a printed paper and with a pen; respondents were randomly stopped in train stations, airports, refectories, bars and parks (within the UK and NL), picked a reply, and, for the optional question ('why?') wrote their reply in a couple of lines.

As the goal was to find out whether, everything else staying constant, pedestrians have preferences regarding the shape of the street, and if so, which preferences. The *ceteris paribus* condition was ensured by proposing the same scenario for each pair of figures (same size of the streets, same pavements, same buildings, same colours, same density, same urban furniture, same design, same functions, etc.) in which the only difference within each pair of figures was the sinuosity of the street.

In addition, for Figure 5 it was also asked 'Imagine to walk 1 km (around 15 minutes) along street A or street B. Which would you feel "shorter"? Do you perceive it to be "shorter" along A or B?'

The options were A, B or Indifferent.

For Figure 6, respondents were asked 'To reach the garden which path would you choose?' The options were A, B or Indifferent.

## Results

The large majority of respondents preferred the sinuous path against the straight in any scenario and any question (Figure 7).

For the scenario in Figure 1, 86.3% of respondents preferred to walk in the sinuous street, against 10.8% who preferred the straight street, while for 2.9% of respondents both streets were indifferent. The most frequent adjectives used to justify the preference towards the curvy street were: cosy, intimate, romantic, prettier, more character, more interesting, less monotonous, seems shorter, more interactive.

Similar results appear for Figure 4, even though in this scenario slightly fewer people preferred the curvy street against the straight (73.5% and 21.6%, respectively), while 4.9% were indifferent.

Figure 1. Examples of straight and curvy streets. Source: Author's photo from Dordrecht, Copenhagen, Boston, New York, Glasgow, Den Haag and Milford-on-Sea.

Figure 2. Examples of straight and curvy streets. Source: Author's photo from the New Forest (UK), Netherlands, Piedmont (IT) countryside.

According to the replies on the question 'why?', some people felt a slight claustrophobic feeling in the curvy scenario because of the small width of the street, while 73.5% preferring the curvy scenario expressed the same adjectives for Figure 3 plus picturesque, intriguing, variety.

The same reply is also confirmed for the scenarios of Figure 5 where 75.3% of respondents preferred the irregular street against the straight, and expressed the following adjectives for the former: less boring, more dynamic, more exciting, more imaginative, feels shorter. A total of 17.5% preferred the straight one, and 7.2% where indifferent to both scenarios.

For the same Figure, 56.9% of respondents felt the curvy path was psychologically shorter than the straight one, even knowing that they were both the same length; 30.4% of respondents felt the straight path was shorter, while for 12.7% of them both streets were equivalent in terms of psychological length.

The last scenario, Figure 6, and related question, added the *goal-directed* walk element, and also in this case the path with the highest angle changes was preferred: 84.4% preferred the route with more changes of angle (four changes); 11.7% the route with fewer changes of angle (one change); while for 3.9% both routes were equally fine.

Considering that, usually, *preferences* over a scene show greater individual variation than judgements of *quality* over a scene (Bell et al. 2001), this robust result is rather remarkable and deserves a deeper investigation with a larger sample and different approaches.

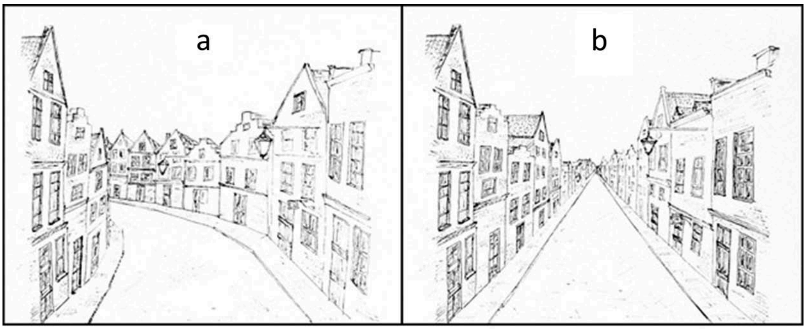


Figure 3. Street comparisons for the questionnaire.

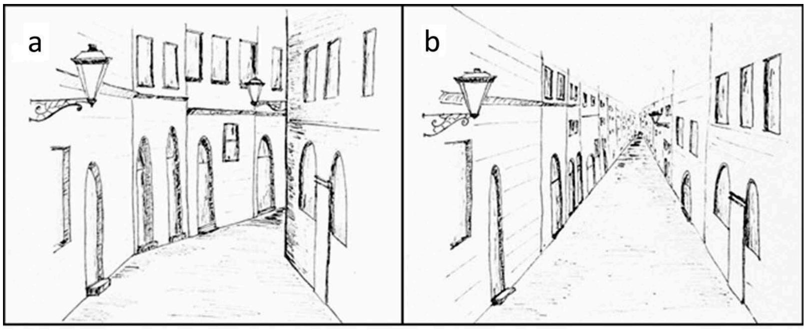


Figure 4. Street comparisons for the questionnaire.

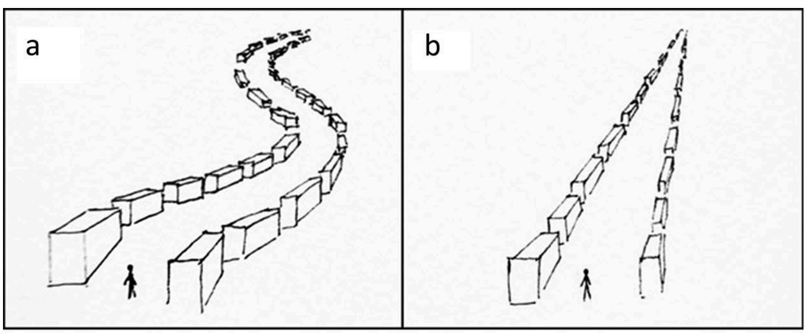


Figure 5. Street comparisons for the questionnaire.

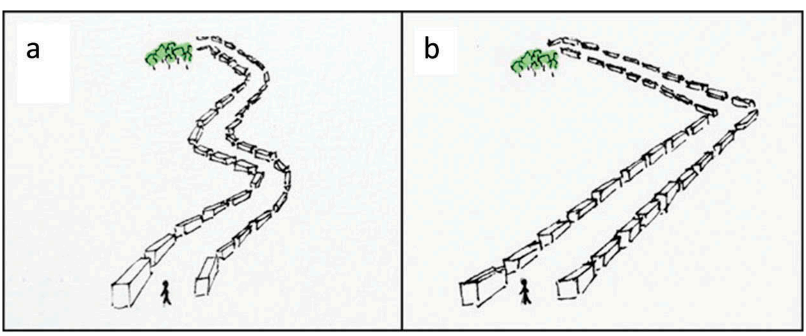


Figure 6. Street comparisons for the questionnaire.

The limited size of the sub-samples per origin country of respondents does not allow testing for eventual geographical cultural influences. However, the three biggest sub-samples (Western Europe, Asia and Central-South America, with respectively 70, 12 and 13 individuals) show similar relative percentages in the replies.

The internal validity of this research result is consistent concerning the causality between expressed preference and street shape, as it is guaranteed by holding fixed all the other variables apart from the shape of the street, thanks to the drawings. Therefore that potential third variable problem is avoided and it is possible to reasonably state the link between the preference and the shape of the street.

However, potential internal issues may be as follows: always having the curvy street on the left of the two pictures shown and the straight on the right; and being influenced

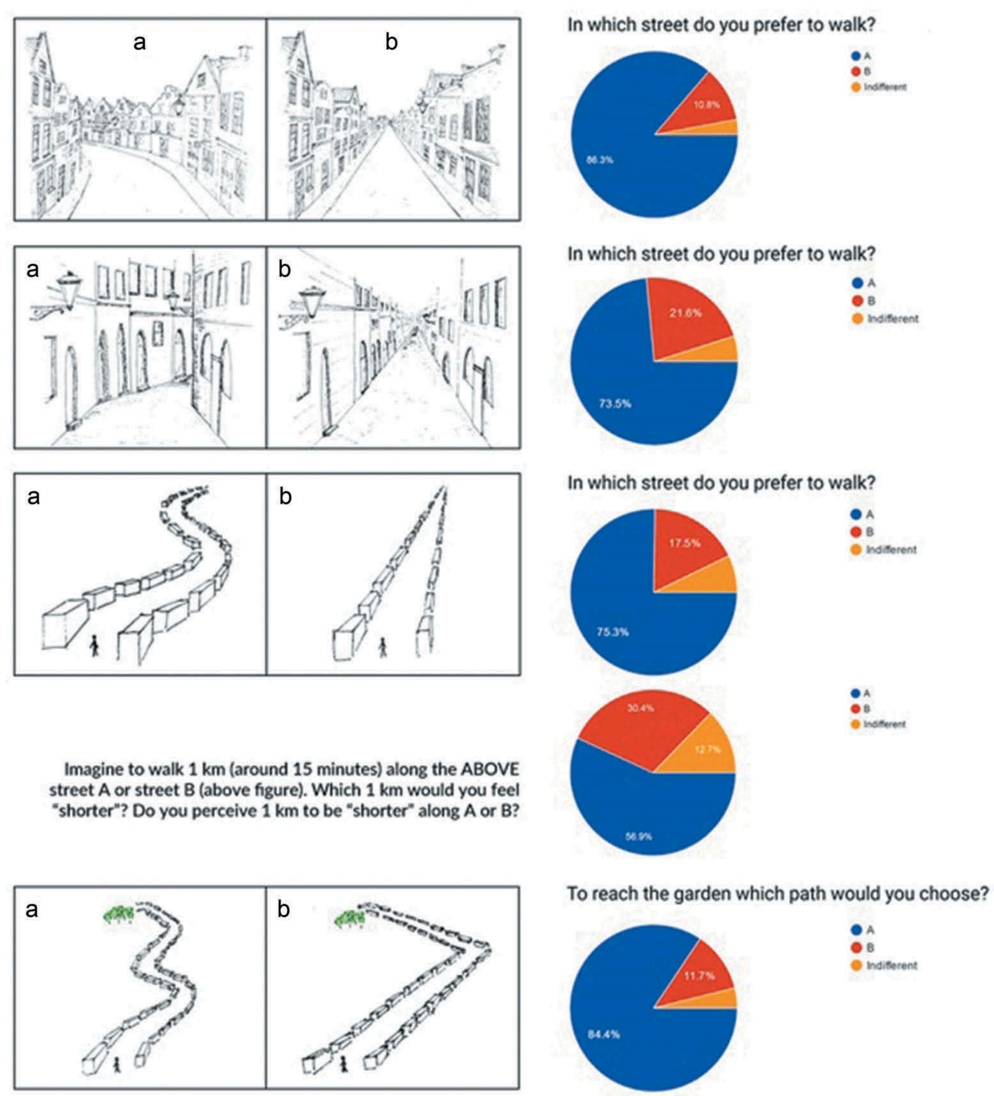


Figure 7. Street preference results.

from the aesthetics of facades (rather than preferring the street shape itself) that are much more visible on the curvy street drawing than on the straight one (for example, if the facades were ugly, someone could prefer to not see them and then choose the straight path for this reason alone). However, another question (Figures 5 and 6) asked the same, but using neutral buildings (standard parallelepiped) to avoid this issue.

Regarding the external validity of these results, limitations of this questionnaire are: a limited sample (even with such a high robust majority in the replies – approximately 80% expressing the same preference – easily allows for generalizations); deeper investigation of possible cultural/sex/age/education/country differences; potential divergences between stated preferences and revealed preferences.

The latter point should verify through observations in the real world the actual movement trajectories and street decisions of pedestrians. If our goal is to isolate the single variable 'street shape' (for a single continuous street, as in this study) or 'path shape' (for a selected path along several possible street combination sequences during a walk), the task may be complicated, if not almost impossible, because of the practical impossibility to find streets/paths differing *only* in their shapes, or to be able to *well* quantify *all* the other differing variables (views, amenities, noise, facades, personal memories, etc.), or to isolate the reasons why pedestrians are walking in one street instead of another, such as for shopping, for work, schools, public transport, etc.. We may observe a large number of pedestrians in a street not so much because of the form of the street itself but for its content, and its content may not be directly or indirectly related to its shape, neither easily/properly quantifiable to insert in a multivariable analysis.

The open question ('why?') of the questionnaire asking respondents, in their words, to explain the reasons of their preference, helps the understanding of the individuals' systems of meaning, whose importance was emphasized throughout the last century among anthropologists and sociologists, particularly the structuralist (Douglas 1977; Canter 2016). From the replies, a general strong similarity was still seen across individuals' meanings associated with street shape, as most of their adjectives are, more or less roughly, synonymous.

In Figures 5 and 6 the views from above allow respondents to see the final destination (Figure 6) and the entire path sequence (Figure 5), which may create a different visual perspective from the real pedestrian view when actually walking, therefore biasing the result. However, it might also be considered that this global vision from the drawing may compensate the situation where pedestrians already know the street, therefore even without being able to see it all in one go (as from the drawing) a person mentally 'sees' it as they know it well.

## Conclusion

Many authors list factors influencing walking behaviours related to physical built environment attributes, among them: Cullen (1971); King et al. (2000); Ball et al. (2001); Hodgson, Page, and Tight (2004); McCormack et al. (2004); Owen et al. (2004); Frank et al. (2005); Lopez and Hynes (2006); Owen et al. (2007); Shigematsu et al. (2009); Inoue et al. (2010); Giles-Corti and Donovan (2002); Van Dyck et al. (2013); Ferrer López, Ruiz Sánchez, and Mars (2015); and Wang et al. (2016).

Modelling approaches to route choice have been explored by many, including: Papadimitriou, Yannis, and Golias (2009); and Xi and Son (2012). Authors who have specifically focused on perceptions of street shapes are: Berlyne (1974); Hagerhall, Purcell, and Taylor (2004); Agrawal, Schlossberg, and Irvin (2008); and Taylor et al. (2011).

Observations supporting that people tend to conserve linearity in their routes are found in: Tolman (1938); Miller (1956); Hillier (1997); Sadalla and Montello (1989); Montello (1991); Zacharias (2001); and Dalton (2003). The questionnaire in this paper shows a different result when we do not invoke people's orientation perception but purely an aesthetical one.

Jansen-Osmann and Wiedenbauer (2004) suggest that people perceive the routes with more turns to be longer; this paper shows an opposite result also for this aspect.

In line with the findings of the questionnaire in this paper, authors emphasizing people's preferences towards more curved streets stimulating curiosity and mystery are: Kaplan (1987, 1988); Kent (1989); Matsumoto, Koyanagi, and Seta (1997); Herzog and Miller (1998); Bell et al. (2001); and Ewing and Handy (2009).

Urban forms, such as street shape, influence our psychological perception of spaces and our behaviour, which in turn determines our urban daily quality of life and our actions.

This paper adds to the literature the fact that pedestrians prefer curvy routes to walk along rather than straight, and feel the former shorter too. The last point is of particular special interest because it is in contradiction with previous assumptions described in the introduction. This has implications both for the urban design/planning arena and the spatial analysis models when they need to compute/weigh distances in their calculations of street network relationships and, in particular, decisions involving route selection in the cases when the main criterion is not the orientation but the aesthetics' (D'Acci Forthcoming).

## Notes

1. 'Partially' because, as will be seen later in the questions of the questionnaire, the respondent had already been informed that the two paths to compare were equally long; the respondent was not asked to quantify (somehow) the two paths, but to express a feeling about which path seemed shorter.
2. Specifically, they used the ratio estimation method, in which respondents draw or indicate lines/shapes to express their own estimated measure of some quantity relative to a standard line/shape representing a standard quantity. In contrast to ratio estimation, another method is the magnitude estimation where respondents provide directly a number to estimate their perceived quantities relative to some standard quantity given in number.
3. In the face-to-face version there was neither interaction nor verbal indications, in order to keep the situation identical with the online version. The same document was given, printed or online. The online version was sent by email to people, keeping in mind the stratification of the sample.

## Disclosure statement

No potential conflict of interest was reported by the author.

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