Choice zones: spatial geometry and real world wayfinding

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Abstract. This note presents preliminary findings from desktop-based eye tracking experiments using real-world stimuli of urban street corners. The fixation and decision patterns are analysed. This leads to a definition of “choice zones” based on space-geometric properties of the gaze bias findings.

Keywords: Wayfinding, eye tracking, real-world, space syntax, spatial geometry

1 Motivation

How do pedestrians decide which way to go in unfamiliar cities? When going to a known destination, one might say that they take the shortest route. There are different ways of measuring shortest path and pedestrians might tend to act on some notion of shortest path, whether or not that notion may be the most accurate. However in an unfamiliar setting, different types of information are useful, such as visual, linguistic and structural information. For example, during business hours people tend to be present in streets where there are also shops. Thus a pedestrian looking for a shop in an unfamiliar city might be likely to choose to go in the direction of crowds of people if these are visible. Signposts, community maps of the area and street names all provide evidence that can help a pedestrian find their way. A growing body of research analyzes how pedestrian behaviour is affected by the structure of the environment ([7], [9], [8], [1]).

The research presented here contributes to the discussion, by analysing empirical evidence of real-world pedestrian navigation from a desktop-based eye tracker. It identifies specific structural elements in a viewshed. This leads to a definition of “choice zones”, that are areas of interest during individual spatial decision-making at urban street junctions. This note presents some preliminary findings from real-world stimuli eye tracking experiments. In particular, the role of spatial geometry is examined: participants choose which way to go whilst their gaze bias is recorded. The recorded data shows where participants look during wayfinding, and the findings shed light on the importance of spatial geometry as a useful form of information at decision points.

2 Methods

15 participants view photographs of street corners and choose which way to go.[1] Eye tracking data records where participants fixate while making wayfinding decisions. The hypothesis that the spatial geometry of the scene draws significant levels of attention during spatial decision-making is tested. Control studies account for the influence of bottom-up and top-down viewing behaviour. A desktop-based ASL EyeTrac 6000 pan/tilt optics remote eye tracker is used.

The stimuli are 28 photographs, taken at urban street corners in the City of London, and taken specifically for the study. Each stimulus presents a decision point with a distinct binary choice of one left and one right path alternative. A number of criteria are used to determine the location and specific angle of each photograph; the final stimulus set includes a version of each stimulus that is mirrored on the vertical axis to test for any left/right bias.

Participants respond to two spatial tasks. The undirected task relates to the most basic form of wayfinding activity. Participants are asked "which way would you go?" with no other information being provided. A directed spatial task specifically sets out to test the role of street connectivity on wayfinding behaviour. Participants are asked "which way would you go to find a taxi rank?".

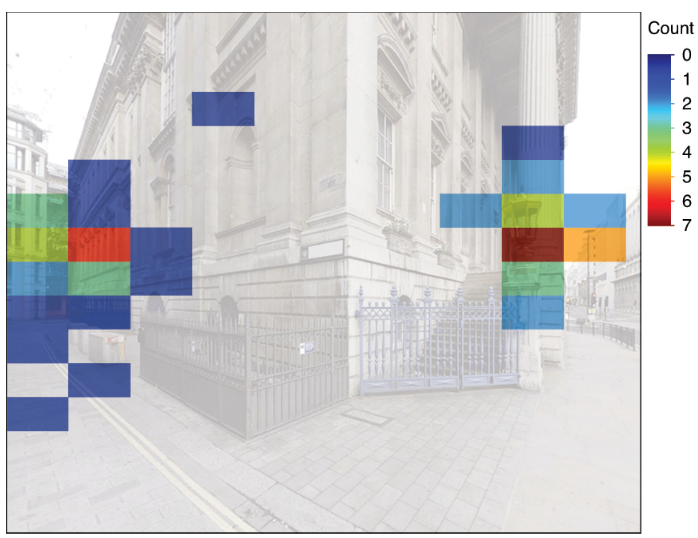

Fig. 1. Example fixation distribution for one stimulus

[1] The full experimental instructions are provided in [4].

3 Observations

This section describes the results regarding the location of fixations, identifying constituent factors in the definition of choice zones.

The distribution of all fixations per stimulus is examined on both the horizontal and vertical axes. This is done by creating fixation density graphs for each stimulus. A trend can be seen across the fixation density graphs. Fixations on the y-axis tend to be close to the horizon line. This is in keeping with results from a previous study [10], as well as with knowledge based on the universal viewing behaviour of photographs. Fixations on the x-axis have two clear peaks, corresponding to the opening up of the view of each path alternative. Evidence of *two* peaks suggests that participants are indeed choosing between path alternatives. Given that they are presented with a forced-choice task, it is clear that there should be an area of interest around each path alternative.

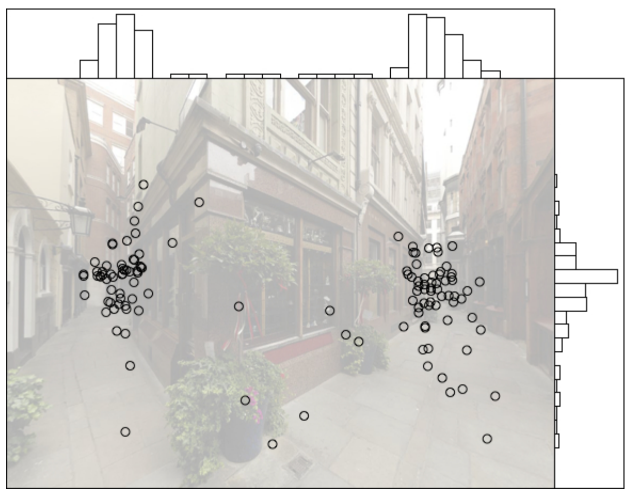

Fig. 2. Example fixation density distributions for one stimulus

The peaks on the x-axis of the fixation density graphs indicate areas of interest around the longest line of sight. This finding is supported by previous research which emphasises the role of depth of view for pedestrian navigation (eg. [6], [2]). However a greater explanation is required for the variation on the x-axis around the longest line of sight. One factor is the arrangement of the building blocks, which define the amount of visible sky.

The distribution of the fixations is discussed in relation to the spatial geometry of the scene. Three space-geometric measures are presented: floor area, sky area, and longest line of sight. These visuo-spatial measures are a refinement of those proposed in [3] and [5]. There are similarities with existing approaches, that are nearly always focussed on what is theoretically visible from a given

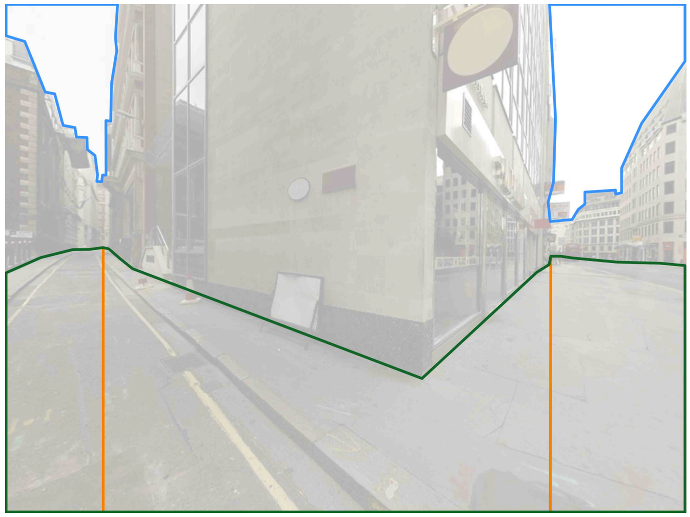

Fig. 3. The spatial structure of the viewshed. The floor area is shown in green; the sky area in blue; and the longest line of sight for each path alternative in orange.

standpoint. A recent paper, however, promotes the relevance of spatial geometry on wayfinding and models recorded gaze bias using a depth-edge profile [10]. The main criticism of such an approach is that the stimuli are all taken from the same equivalence class, that is, the horizon line tends to be at a consistent point across the stimulus set. One of the challenges of real-world studies is to encompass situations where this is not the case, as navigation in physical environments always involves changing horizon lines, and is determined by the perspective and visual stimulus available to the individual. Other methods (eg. isovists, VGA etc.) are based solely on the theoretical amount of information as measured from blueprint plans. While advances to knowledge have been attained through such approaches, this body of research now needs to be complemented by behavioural and psychological explanations regarding how real-world stimuli are used. Theoretically available information alone need not match the actual amount of information gained and/or used by individuals in all but the most simple environments.

4 Discussion

The above observations examine the relevance of space-geometric measures on fixation data recorded during wayfinding. Choice zones are identified, incorporating those elements that are most relevant to real-world analysis. The significant constituents of this specific measure account for the spatial geometric properties of the gaze bias findings. Overall, 80% of fixations fall into the choice zone areas. More specifically, i) 95% of fixations are above street level; ii) more than 90% of fixations are below the sky area; iii) the horizontal location of the choice zone clusters is defined by depth of view.

A number of candidate definitions of choice zone areas are possible based on the aforementioned observations. These will have to be assessed in light of future applications. This is the object of my ongoing research, involving collaborations with psychologists and neuroscientists. It is hoped that such a measure can be used by practitioners in real projects and by researchers using real-world stimuli.

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