Wayfinding in unfamiliar environments: Report of a real-world study using eye tracking

Beatrix Emo, Tyler Thrash, Victor Schinazi, and Chirstoph Hölscher
Chair of Cognitive Science, ETH Zürich

1. Introduction

What is the role of spatial geometry during wayfinding? We tested the case of **unaided** wayfinding in **unfamiliar** environments. The study examines **individual spatial decision-making at city street junctions** using eye tracking. A mobile eye tracker provides an insight into the decision-making process during navigation. The study aims to contribute to **evidence-based urban design principles** that can be used to improve the usability and user experience of urban environments.

2. Background

How important is spatial geometry on urban decision-making? Is **street connectivity** a salient variable? Evidence from existing studies suggest that significant **changes in the local geometry**, such as large changes in the depth of view, are an important factor during wayfinding (Dalton, 2003; Wiener et al., 2012; Emo, 2014).

Figure 1. (a) Three space geometric parameters: floor line (black), sky line (blue) and depth of view (orange lines). **(b)** Choice zones are areas of the visual scene that account for visual attention during navigation; they are defined using the space-geometric parameters illustrated in fig. 1a.

Our study follows on from a laboratory-based eye tracking study which showed that gaze bias during wayfinding, for the case of navigation with two path alternatives, is directed at certain areas of the scene (Emo, 2014). These areas are termed **"choice zones"** (fig. 1b) and are defined using **three space-geometric parameters** (fig. 1a): floor line (the line that separates the buildings from the street and defines walkable space), sky line (the lowest point of the visible sky area) and depth of view (the longest line of sight is the highest point on the floor line). One aim of this study is to test the applicability of choice zones in a real-world setting.

3. Experimental design

Participants, **unfamiliar** with the area, were taken to a pedestrian-only part of downtown Zürich (fig. 2a). They were asked to **find a landmark** (the main station - not visible from the square) without using any maps/mobile device or asking for directions. There are four possible routes out of the square (these are shown in fig. 2b). Participants were **free to take any route**, there was no correct route; that is, they had a free path choice out of the starting location and for all subsequent path segments. The experiment ended once they reached the experiment boundary (a vehicular road, or the river; boundary shown in red in fig. 2b).

A **mobile eye tracker** was used to record gaze bias (SMI Eye Tracking Glasses 2.0). Initial data streams show that it will be possible to collect high-quality eye movement data using such a device, out-of-doors, under changing lighting conditions (fig. 4).

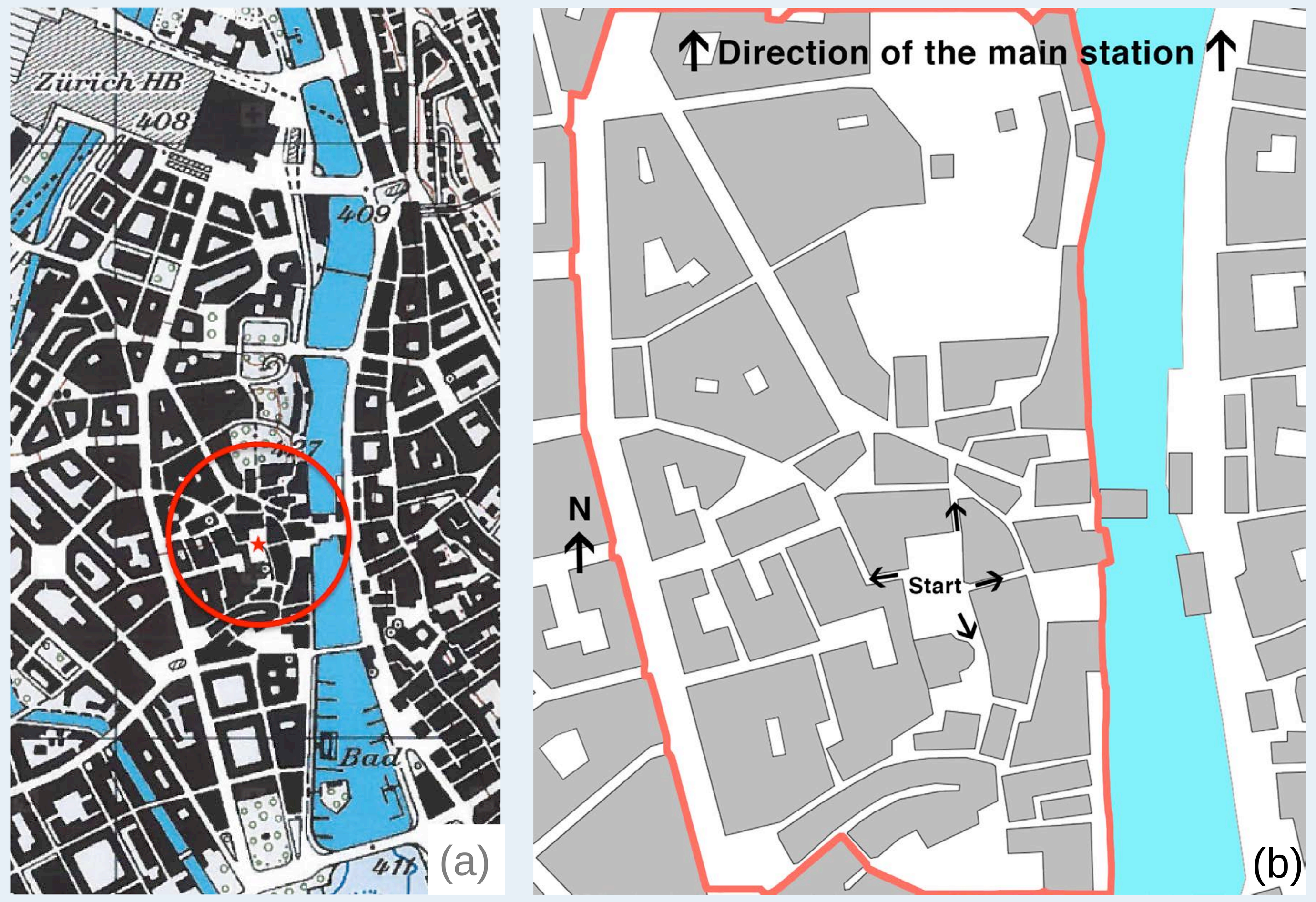

Figure 2. (a) Experiment location in downtown Zurich; the main station is shown top left.
(b) Close-up of the case study area, with the experiment boundary shown in red, and the four possible exits of the starting location highlighted.

Factors that might influence route choice & should be controlled for include:

- Direction from which square is entered;
- Direction in which participants face at start of experiment;
- How participants are taken to the starting location, to prevent them acquiring any familiarity with the area.

4. Pilot study

The behavioural data of **five participants** from the pilot study is reported. All participants chose different routes (fig 3). Four participants took the same initial route out of the starting location. Two participants went towards the main road (Bahnhofstrasse) leading to the main station (green and blue routes in fig. 3). Another route went via a park on a hill (yellow route trace). Two routes headed for the river (red and orange routes). No participant headed south out of the starting square, away from the main station.

Initial analysis does not suggest any bias relating to **street connectivity**. The connectivity of the chosen path segment in relation to all possible segments at each junction was analysed. On average, participants chose, in equal proportion, the path segment that had the same connectivity value, or a value +1 or -1 of its neighbour. Additional analysis will test this further.

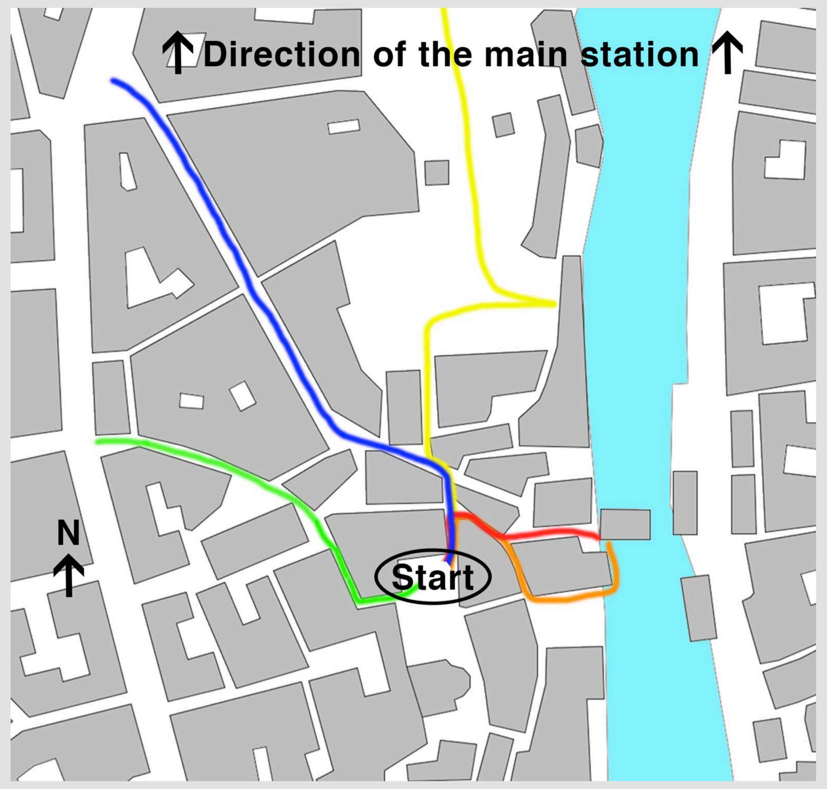

Figure 3. Routes taken during the pilot study by five participants.

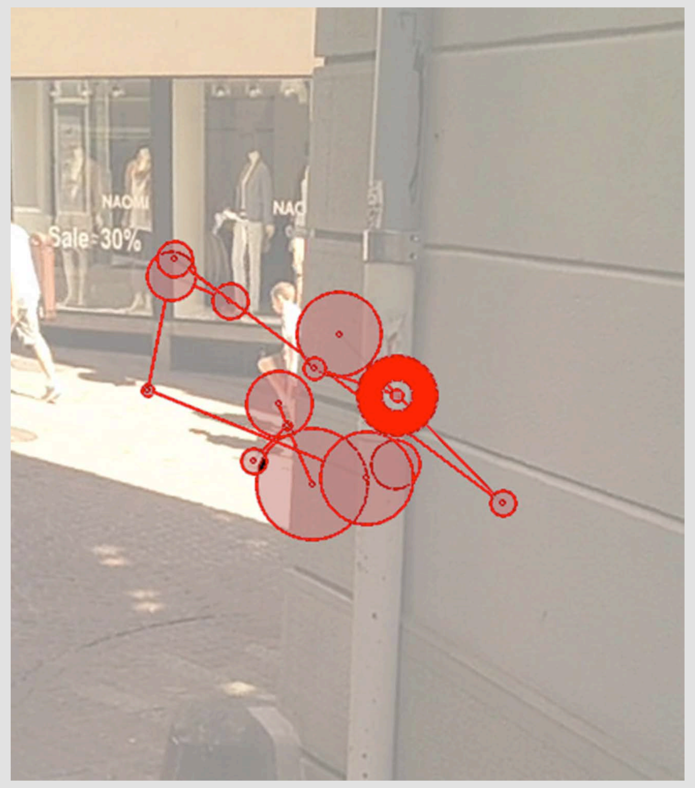

Figure 4. Example scan path showing fixations of one participant when approaching a corner.

Analysis is currently underway to examine possible wayfinding strategies, using the eye tracking data to explore how much attention was paid to the **spatial structure of the scene** during the decision-making process (fig. 4). The relevance of space-geometric parameters, and the validity of the choice zones concept, (fig. 1) will be tested.

5. References

Dalton, R.C.: The secret is to follow your nose: route path selection and angularity. Environment and Behavior 35(1), 107–131 (2003)
Emo, B.: Seeing the axial line: evidence from wayfinding experiments. Behavioral Sciences 4(3), 167–180 (2014)
Wiener, J.M., Hölscher, C., Büchner, S., Konieczny, L.: Gaze behaviour during space perception and spatial decision making. Psychological Research 76, 713–729 (2012)