SUPPORTING THE NAVIGATION TASK: CHARACTERISTICS OF 'GOOD' LANDMARKS

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Landmarks (e.g. traffic lights, churches, monuments) have great potential to support travellers in navigation tasks. Concern has been expressed regarding the current generation of vehicle navigation systems and their reliance on distances, rather than landmark information, particularly within their voice instructions. This paper describes a direction-giving study which aimed to establish which landmarks are valued for navigation and their salient characteristics. Participants (n=32) provided written directions for three urban routes, based on either a single experience of the routes (via a video), or their long-term experience of the area. The study revealed the significance of 'road furniture' landmarks, such as traffic lights, pedestrian crossings and petrol stations. Prospective attributes of these landmarks include permanence, visibility, location in relation to a decision point, uniqueness and brevity.

Introduction

Finding one's way (whether in real or electronic worlds) is a complex human activity. Difficulties with this everyday task often cause stress and frustration for the individual and inefficiency within travelling networks. For road vehicles, the navigational uncertainty that arises from current methods (e.g. handwritten notes, paper maps) can affect drivers' behaviour in a number of undesirable ways. For instance, at the manoeuvering/tactical level of the driving task, there may be an inappropriate use of indicators, sudden lane changes or late/sharp braking. In contrast, at the strategic level of driving, drivers may make poor route choices or may avoid unfamiliar environments. Older drivers in particular have been shown to consciously adapt their driving habits as a result of navigation demands (Burns, 1997).

Advancements in computing, communications and map technologies have led to the development of GPS-based vehicle navigation systems (or 'SAT NAV'). This technology has been available to drivers in Europe since the mid 1990s, and the prediction is that it will

be commonplace as the market matures and costs fall (Rowell, 1999). Many of the current systems provide instructions (using symbols and/or text and often voice messages) that indicate the location and direction of each turning. For systems that utilise a large LCD, map-based information can also be accessed.

The ergonomics/human factors issues for this technology have constituted an area of considerable activity for researchers in the last 15 years or so (see Srinivasan, 1999 for a recent review). This focus is not surprising given that a) this technology is arguably the most sophisticated with which drivers have had to interact within vehicles, and, b) much of the system functionality is of potential use when the vehicle is in motion. One clear finding of research has been the importance of voice messages for safe and effective interactions (Kishi and Sugiura, 1993; Burnett and Parkes, 1993). An outstanding issue of concern, however, is the *content* of voice messages. Current systems tend to emphasise distance-to-turn information, using either exact figures (e.g. "right turn in 200 metres") or informal, time-based terms (e.g. "right turn coming up"). Research has indicated that a much wider range of information types are used in navigation tasks, in particular landmarks, e.g. traffic lights, petrol stations, churches (Burnett, 1998). Furthermore, studies have revealed how the inclusion of landmarks within vehicle navigation systems can increase the effectiveness, efficiency and satisfaction of the system for users (see Burnett, 2000 for a review).

However, if such features of the environment are to be included in future systems, it is imperative that there is a detailed and practical understanding of what constitutes a 'good' landmark. The inappropriate use of landmarks (e.g. those which are poorly visible or cannot be readily identified) may lead to driver confusion and reduce, rather than increase the usability of a vehicle navigation system. On this issue, there are recommendations in the human factors literature regarding good types or classes of landmark, and a consistent finding across several studies is the potential for traffic lights, petrol stations and bridges as landmarks for navigation (see Burnett, 1998 for a review). Unfortunately, such guidance does not account for the fact that landmark quality varies considerably from one situation to another (even for the best overall landmarks). For example, it can be difficult to identify a correct set of traffic lights associated with a turning in contexts when there are several sets close to one another. What is needed ideally is a generic understanding of the characteristics that *define* a good landmark, so that the best landmarks can be chosen on a case-by-case basis. It is believed that such knowledge will be beneficial for the analysis of landmarks in other navigational contexts (for pedestrians, within information space, virtual worlds, etc.).

Method

A study was devised in which 32 participants (16 male, 16 female; age range 22 to 60; all experienced drivers) were asked to write down the information they felt an unfamiliar traveller would need to drive and navigate three linked routes successfully. All routes were within an urban driving environment, covered approximately ten miles in total distance, involved 19 distinct decision points (i.e. junctions where navigational uncertainty would be expected), and took approximately 24 minutes to drive.

In a factorial design experiment, two conditions were adopted, whereby participants provided directions based on either A - a single experience of the routes (via a video) (n=16),

or B - long-term experience of that driving environment (n=16). For A, participants had no prior experience of the routes, whereas for B, participants had lived and/or worked in the test area for at least five years.

Each of these conditions is associated with its own merits and problems (see Table 1). By examining which landmarks are commonly referred to by *both* groups (i.e. the degree of overlap), it is argued that one has the best set of potential navigational landmarks.

Table 1. Pros and cons of different information sources for direction giving studies

Condition	Advantages	Disadvantages
Single experience (via video)	Based on direct observation – the view of an unfamiliar traveller	A 'snap-shot' experience of routes – therefore, limited by specific views available
Long-term experience (via memory of locals)	Based on repeated exposure to landmarks – gives overall view of merits	Individual's memory for landmarks prone to subjective biases

Initially, participants were informed of the general nature of the study (concerning the directions people use for navigation). To avoid bias, no mention of landmarks was made. For participants in the single experience condition, the routes were filmed in an experimental car using a micro 'lipstick' camera mounted in front of the rear view mirror and forward facing. The focal length of the lens was 7.5mm representing a viewing angle of 45 degrees. These participants were shown this video and were permitted to rewind and review any part of the video until they felt happy with their route descriptions. Participants in the long-term experience condition were initially provided with a 'minimal' schematic map of the routes. These maps were carefully designed to provide sufficient information to enable participants to 'realise' the intended route, without affecting the directions they would give.

Once the participants had written their directions for all three routes, they completed questionnaires concerning their overall strategies and perceived abilities for navigation. The experimenter used this time to highlight all landmarks contained within their directions. Participants were then interviewed in a semi-structured style regarding their reasons for choosing landmarks. Specifically, for each landmark within their directions, participants were asked why they had referred to such an object/feature of the environment, what made it stand out from other potential information, etc.?

Analysis and results

In the first instance, the written directions provided by participants were examined and a frequency count was conducted for each specific landmark (e.g. the traffic lights at the junction of Lee Way and Park Drive). Figure 1 plots the number of participants who referred to a specific landmark in their directions for both conditions. The most valued landmarks across the two groups are those with data points located towards the top right of the graph. The figure demonstrates the relative importance/value attached by individuals to designed objects within the road infrastructure, or 'road furniture' landmarks (e.g. traffic lights and petrol stations). Indeed, over a third of all landmark references made were for traffic lights.
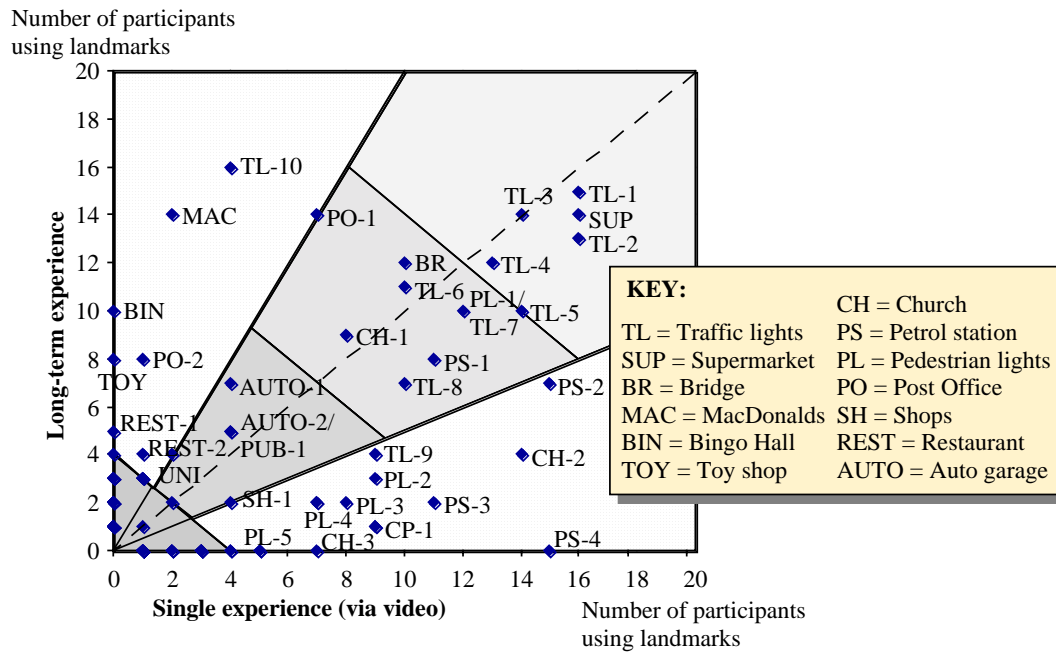
Figure 1. Numbers of participants referring to specific landmarks based on single versus long-term experience of routes

To identify the generic characteristics of good landmarks from this study, two approaches were taken. Firstly, two human factors experts independently examined the transcripts from the interviews and grouped the reasons given for landmark choice. Secondly, a third human factors expert considered the contextual differences between landmark types that were either commonly or infrequently used in directions. For instance, this individual contemplated why a set of traffic lights were popular in one situation, yet a different set were rarely noted within participants' directions.

A strong consensus emerged from these analyses, and Table 2 proposes an initial list of salient characteristics of the valued landmarks. For illustration purposes, the table also provides examples of landmarks that typically score highly/poorly on each of the attributes.

Discussion and conclusions

From Table 2, one can see that for permanence (the longevity of the landmark), both form and labelling were considered important. These factors are linked to how a landmark might be presented to a driver. Many landmarks will frequently change their labelling (e.g. a BP petrol station becoming Shell), whilst maintaining their basic form/function. Consequently, landmarks that lend themselves to a generic (unlabelled) presentation may be preferable for use within a vehicle navigation system.

Table 2. Characteristics of valued landmarks for navigation

Attributes of valued landmarks	Landmarks that score *highly* on the attribute	Landmarks that score *poorly* on the attribute
Permanence - the likelihood of the landmark being present, either in • Form (shape/size etc.) or • Label (name, logo, etc.)	Churches, Woods Monuments, Schools	Factories Shops, Petrol stations
Visibility - whether the landmark can be clearly seen in all conditions	24 hr Petrol Stations, Pedestrian crossings	Post-boxes, Street names
Usefulness of Location - whether the landmark is located close to navigational decision points	Traffic lights, Corner shops	Rivers, Railway lines
Uniqueness - the likelihood of the landmark *not* being mistaken for other objects/features, either due to: • A highly individual appearance • Being located apart from landmarks of same type	Bridges, Roundabouts Railway stations, Parks	Repairs garages Traffic lights
Brevity – the conciseness of description associated with a landmark	Traffic lights	Large white house on the left

The factor of 'brevity' relates to the number of terms/words used by participants to refer to different landmarks. For certain landmarks, there was a marked tendency for people to use more descriptive terms. Table 3 shows typical expressions used by participants for two example landmarks, and highlights some quantitative and qualitative differences that arose between the two conditions.

Table 3. Examples of typical terms used to refer to two landmarks

Terms based on single experience	Roman looking building	Big flat-roofed Georgian looking building
Terms based on long-term experience	St Mary's Catholic Church	General Post Office

Relating to brevity, it is argued that good landmarks require the minimum of additional information to be usable. As an example, the appearance (and to a lesser extent, the position)

of traffic lights is evident purely from the name. Landmarks that require lengthy descriptions will be associated with increased demands within a vehicle navigation system interface, since the driver will be required to process several different information elements.

The data provided by this study has enabled an initial understanding of the generic characteristics of landmarks that make them suitable for navigation purposes. It is likely that all of the characteristics within Table 2 will, under particular conditions, contribute to what constitutes a 'good' landmark for navigation. However, it is also probable that some will be consistently more important than others, that is, they will influence the success or failure of a landmark on a greater number of occasions. In this respect, as a next step, it is vital to understand the relative importance of the different factors.

A further issue concerns how these factors can be measured. To address this question, one must first consider who would carry out the measurements (map database personnel, navigation system developers?), and with what information sources (from a map, direct observation?). A full understanding of these practicalities will dictate how the benefits of landmarks can be realised in future vehicle navigation systems.

Acknowledgements

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