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Not Another Google Map: Experimenting with heat maps in the design of online travel guides

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Abstract

Most online travel maps that are designed to give an overview of a city are made using the Google Maps API and pins to represent points of interest on the map. This study proposes that in order to give a better overview of a place to a user that may not know the layout of a city, heat maps could be used along with a simpler base layer map with fewer geographical features. Two different prototypes of map design were developed and tested alongside the original Google design in an online study completed by 72 people. The study found that many users responded positively towards the prototypes and some ranked them higher than the standard Google design when asked to choose which map they preferred, practically and aesthetically. The research uses this data to make some basic recommendations about future online map design for travel websites.

Keywords: heat mapping, travel maps, GIS, online cartography

Contents

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And thanks to Charlie Perry for the breakfasts.

1. Introduction

In the infancy of the world wide web (WWW), it was predicted that travel information websites of the future would feature 'attractive and efficient' (Brown, 2001) maps that made use of available technology and adhered to accepted design principles while satisfying the needs of the user.

Twelve years on, it is not clear whether the destination maps on popular travel websites such as Guardian Travel[1] are fulfilling the criteria imagined by Brown. Do the maps embedded in the Guardian's City Guides[2], claimed by the website to be 'beautiful' (Lanyado *et al.*, 2012) and 'authoritative' (Pietrasik, 2012) and intended as an overview guide of a city in order to help tourists make decisions and answer questions about their upcoming trip such as "where should I stay?" or "what are the interesting parts of a city that I might like to see?", actually help the user in the way they are intended? Given that the aim of many large travel websites is to inform the user about a destination in order to convince them to purchase flights, accommodation or tours, the effectiveness of such overview maps is relevant to these websites and to our understanding of online map design and user interaction with these maps.

This research is an attempt to explore the effectiveness of what will be referred to throughout the report as 'Google pin maps' – the recognisable Google street map base layer design with an overlay of pins denoting various points of interest to the tourist – hotels, restaurants, bars, shops, museums and other attractions. These maps have been a common feature on travel websites since the introduction of Google Maps' API. But if a tourist using one of these maps is unfamiliar with the layout of a city, as might be reasonably expected, is such interaction a hindrance and therefore irrelevant to the users' needs? Does a cluster of pinpoints on a street map – layered over other potentially irrelevant information – really help users unfamiliar with the geography of a place achieve their goal of planning their trip?

The project will propose two alternative designs, both including the use of a density surface map (referred to as 'heat maps' throughout), in order to evaluate the effectiveness of the Google pin maps when compared with the alternatives, and also to evaluate whether the heat maps, combined with a simpler map base layer, could be an effective alternatives to the Google maps when a user is asking the preliminary question 'Where should I stay?'.

[1] www.guardian.co.uk/travel
[2] http://www.guardian.co.uk/travel/city-guides

The research was carried out with the assistance and cooperation of the User Experience team at *The Guardian*, who were aware that there was a lack of data or insight into how their users interacted with the Guardian City Guide maps.

1.1 Research question, aims and objectives

This research will attempt to answer the following question:

Are heat maps an effective alternative to Google Maps when visualising information about a city for people in the pre-planning stage of a holiday?

The aim of the research is:

To determine if heat maps are an effective alternative to Google Maps when visualising information about a city for people in the pre-planning stage of a holiday.

The research will attempt to meet the following objectives:

1. Discover alternative forms of map design and or visualisation of city information for tourists that might be combined with a heat map layer to form an alternative to the tradition Google Maps with pins currently used by the Guardian Travel website.

2. Create prototypes of these maps using available technology and programming languages

3. Develop and test a survey to evaluate these new maps/visualisations

4. Conduct a user survey to evaluate the alternative heat map designs against the Google Map design.

Sections two and three of this report cover the design and development of the heat map prototypes. Section four discusses in detail the development of the online study, and sections five and six discuss the results of the study and possible design recommendations.

2. Literature review

This research project, with its focus on online travel map design and heat mapping, falls into several overlapping disciplines. General principles of map design and geovisualisation, then heat maps, form the basis of this literature review, followed by research into online and mobile travel applications and lastly the needs of users planning travel online.

2.1 Map design

Map design is subjective and when designing maps, the designer must think about what the map is being used for in order to create a map that is 'optimal … for the task at hand' (MacEachren, 1994). Despite their familiarity to most people, maps are abstract and it is up to the designer to make decisions about the design as well as the data included in the maps (MacEachren 1994, 1995).

MacEachren (1994, 1995) notes that maps are used as communication devices and can be used to allow people to explore data sets. While this is somewhat the case with the current convention of using Google pin maps to present information relevant to the traveller, travel maps could go further in presenting data that is completely tailored for individual travellers that filters out irrelevant or default information.

Slocum et al (2009) argues that there is a difference between 'general-reference maps' and 'thematic maps' (Slocum *et al.*, 2009), with the former being a map purely designed to show what exists in a place, such as a highway map, and the latter being designed to convey a message (also see MacEachren, 1994 on maps as 'visual thinking tools'). Using Google pin maps to show information relevant to travellers is an unsophisticated way to present such information that the map is almost a general-reference map; this study will aim to see if it is possible to create a better design, preferred by users, that is more 'thematic' in its approach.

2.2 Online mapping

The WWW is an ideal place for travel-related mapping as tourists can access information about a destination alongside other relevant services such as online hotel reservations (Brown, 2001) both before the trip, and, increasingly due to the use of mobile devices, during it, as evaluated by Mountain and MacFarlane (2007).

Van Elzakker (2001) observed that online maps are used in different ways than traditional print maps. Rather than using a map with defined boundaries dictated by city limits as one would do when using print maps, online maps can be limitless and are often used to give specific answers to questions such as where to find a

restaurant or where the nearest cinema is, in a way that is not possible when using paper maps. Online maps can be instantly tailored to the needs of the user and what they need to know about the destination they're travelling to.

However, despite the integration of the key information visualisation techniques of 'overview first, zoom and filter, then details-on-demand' (Shneiderman, 1996) that add interactivity and a way of displaying such personally relevant data as it is required to online mapping services such as Google Maps, tourist maps on major travel sites such as The Guardian[3] and Lonely Planet[4] still largely resemble print maps with their detailed street plans and distributions, despite many recommendations about the design of such maps having been made from a usability perspective (Nivala *et al.,* 2008; Harrower *et al.*, 1997; Arleth, 1999) and a technical perspective (Jenny *et al.*, 2008).

Nivala *et al.* (2008)'s usability evaluation of four different online mapping services showed that online maps, including Google Maps, often fail to meet recommended design guidelines, such as that colours should be simple and 'in harmony' (Nivala *et al.*, 2008) and that consideration should be given to what information should be included at each map scale level.

2.3 Use of data to create personal relevancy in maps

The increasing amount of data generated by users of online and mobile services means that there is an abundance of data with which to create personal Flickr[5], Panoramio[6], FourSquare[7], Twitter[8], Facebook[9] and other social networks have all been explored as potential sources of data to create rich, interactive online maps with personal relevance to the user, particularly the user who is also a traveller (Clements *et al.*, 2010, Kurashima *et al.*, 2010, Girardin *et al.,* 2008). Similarly, data gathered from the online searches conducted by tourists prior to embarking on a holiday can also be used to create more relevant and personalised maps (Fisher, 2007).

The 'digital footprint' (Girardin *et al.*, 2008) left by tourists visiting a city, through mobile searches, social media check-ins, map searches and other digital interactions has the potential to be exploited in a variety of map visualisations for users both planning a trip and on the ground in a city. Such visualisations could use data in the

[3] http://www.guardian.co.uk/travel/city-guides
[4] http://www.lonelyplanet.com
[5]http://www.flickr.com
[6] http://www.panoramio.com
[7] http://www.foursquare.com
[8] http://www.twitter.com
[9] http://www.facebook.com

approach discussed by Wood *et al.* (2007), who created a range of maps including density surface maps from user-generated data. This sort of data, while not available for the research project outlined in this report, could be used in future iterations of the mapping prototypes developed in this project.

De Sabbata and Reichenbacher (2012), in their research into the concept of 'geographic relevance', aimed at ascertaining the type of information relevant to users when accessing maps on a mobile device, and showing that relevance must be considered as a design element. Their work included an online study that asked users to consider information about a fictional place and make a hotel choice based on that information and their location. This study forms the basis of some of the research undertaken in this research report.

2.4 'Heat maps'

MacEachren (1994) and Slocum (2009)'s dictum that maps can either be general or thematic indicate that the current method of holiday overview maps being made with the Google Maps API could be rethought or challenged.

Lehrburger (2009)'s *Where do you go?* project is an attempt to create a tool to visualise the movements of one user through the prism of their FourSquare check-ins. The data generated by the FourSquare app is used to create a heat map overlayed over Google Maps, providing more complexity to the map and giving it the ability to expose patterns and trends in the data. This type of 'heat map', a basic density surface map, could be adapted to show data relevant to travellers, such as the best hotels, restaurants or sites. Such a prototype, albeit currently in beta testing mode, has been implemented by the travel booking website Hipmunk[10], although it is unclear how this data was generated for the site.

Density surface maps are an appropriate way of visualising data at set points that does not conform to set boundaries, e.g. counties. Isometric maps, with their continuous surfaces utilise 'true point data', which is data that can be taken at a point location on a map, e.g. the recorded snowfall at an address (Slocum *et al.*, 2009). As shown in Lehrburger's work and the preliminary Hipmunk site design, these maps could be useful for providing an overview for travellers of which areas in a city they might be interested in visiting.

[10] www.hipmunk.com

2.5 Colour

The importance of a colour scheme in any mapping project cannot be overestimated but is often overlooked in online mapping; indeed this is something that is covered extensively in the literature primarily by Brewer. Harrower and Brewer's ColorBrewer (2003) is an online tool that recommends appropriate colour schemes for maps depending on what medium the map will be produced in (online, printed etc) and what type of data is used:. sequential (ordinal data, e.g. age ranges), diverging (where there is a 'critical break point' in the data classes, e.g. on an average temperature map, where there are average temperatures below 0°C) and qualitative (nominal data, where there is no order implied but the classes are different, e.g. most common type of pet owned in a neighbourhood). ColorBrewer's qualitative colour schemes include a grouping called 'Accent' with some visually stronger colours, enabling the map designer to draw attention to a particular class of data (Harrower and Brewer, 2003). MacEachren (1994) provides useful guidelines for the use of colour and other graphic variables on maps, arguing that hue is only a 'marginally effective' variable on maps displaying ordinal data, which would be the case on a heat map.

Spotlighting is an experimental technique that has been used to show trends in a visual fashion where the points on a map with the most data are coloured in the lightest colour, in order to draw attention to, or 'spotlight' the most important information or classes (Dykes and Mountain, 2003). In a map aimed at tourists wanting to find information and make speedy decisions, this could be a possible way of visualising the information.

2.6 Information needs of the traveller

What of the needs of the user planning a holiday? What information does a person sitting at a computer or mobile device after (or perhaps before) booked a flight need to know? Little research has been done in the field of travel and tourism studies to answer this question except from a marketing perspective, which has been deemed as not relevant to the research described in this report, with its focus on usability.

GIS research has focused on data available to visualise and personalise the information required. Dykes and Mountain (2003) have shown that point-based location data collected from individuals over time can reveal when visualised that first-time travellers travel widely rather than focusing on specific areas of interest. From this it can be inferred that the traveller may require 'the most generic information' (Dykes and Mountain, 2003) on their first visit, with more information on points of interest and less frequently visited sights on their second or third visit to their destination. This first visit, requiring more generic information, could now be

conducted online when the user is planning their holiday according to their interests and making key decisions about their trip.

De Sabbata and Reichenbacher (2012)'s study into geographic relevance for the design of mobile mapping applications has implications for the design of online maps even if used on a desktop PC because it underlines the necessity for information to be relevant, particularly with the amount of data available to create such maps.

3. Methods

This research project aims to identify and develop alternative visualisations to traditional Google Maps and then test these new visualisations against existing ones in order to evaluate their effectiveness, design and discover whether users have a preference for any one type of visualisation.

It is important to compare other experimental types of maps with the Google Maps to increase our body of knowledge on user behaviour when booking travel online, user interaction and satisfaction with Google Maps, and user responses to more experimental visualisations of travel information.

The following section focuses on how these methodological problems were solved: firstly, how alternative maps were designed, developed and why such visualisations were chosen; how the study was designed and why; and who was recruited for the online study.

3.1 Development of map prototypes to test against 'standard' map

The research and development of new mapping prototypes grew out of a frustration with Google pins not showing trends clearly enough to a user unfamiliar with a city, and possibly showing more information than required by a first-time visitor.

In order to test the effectiveness of the standard Google pin map, alternative maps were designed according to the following design choices.

3.1.1 Design Choice 1: heat map

It was decided that density surface maps ('heat maps'), in the style of Lehrburger (2009), had the potential to more clearly show trends or areas of interest to a traveller in the form of an overview map, thus allowing them to make faster and possibly more informed decisions on where to stay in a city. The trends to represent on such a heat map are only limited to the data available, which could include the location of restaurants, tourist sites or shops in a city, more statistical information such as crime statistics, demographic profile of a city or even the level of happiness of residents in different districts in a city, or user-generated information provided by visitors to a city such as the digital footprint explored by Girardin *et al.* (2008).

It was agreed with the user research team at the Guardian that an appropriate type of data to test would be restaurant information, as the content on their site and Google Pin maps contains a large amount of information about dining options in city, and this would allow a situation where realistic maps that could in future appear on their website would be tested against their current maps, testing like for like.

Several methods of creating these heat maps were explored, including using the Google Maps API and fusion tables, offline mapping software such as Quantum GIS or xxxx, newer online map creation services such as MapBox, or simply mocking up realistic-looking data in a graphics package such as Adobe PhotoShop or Adobe Illustrator. However, it was decided that a JavaScript library would meet the requirements best. Heatmap.js, an open-source library developed by Wied (2011) dynamically creates heat maps over GoogleMaps, OpenStreetMaps and other base data, and has been used on a variety of online mapping projects (Coote, 2012; Hernandez and Hoque, 2011). It is flexible enough to allow the user project the data over different base layers, change the radius of points etc and customise the hue and opacity of the data classes and even the number of data classes given in the map.

Heatmap.js was an appropriate choice over other options given the time available for the project and the technical ability of the author, who is not a trained cartographer and did not have the skills or time to learn more complex specialised mapping packages. JavaScript libraries of this sort are also an appropriate choice for large websites such as The Guardian, which are accessed by millions of unique visitors and must take the loading speed of a page into consideration as well as accessibility.

3.1.2 Design Choice 2: Base layer

In order to test the effectiveness of another map style, it was decided that another variable, that of the map base layer, should be added to the user study. As Tufte stated, 'clutter is a failure of design, not an attribute of information' (Tufte, 1990), so it was decided that the map base layer should be a simpler design than that of Google's. Tufte's statement was echoed in the more recent detailed user studies of internet cartography (Nivala *et al.*, 2008; Harrower *et al.*, 1997), that observed that internet maps users had different requirements to paper map users and that consideration should be made of what information is included on the map, depending on the users' requirements, and that information surplus to the users' requirements should be removed.

With this in mind, it was decided that a simpler map base layer should be tested against the standard Google Maps layer. Various options were considered, including the basic OpenStreetMaps[11] design (OSM) and those developed by Leaflet[12]. OSM was rejected because, although it looks different enough to the Google Maps design that even the most casual internet map user would be able to distinguish between them, the map design is still quite cluttered (a subject of which deserves further user investigation of its own). Leaflet was considered because of its customisable,

[11] www.openstreetmap.org
[12] http://leafletjs.com/

streamlined maps, but ultimately also rejected due to technical constraints and the way it interacts with the heatmap.js library.

'Toner', designed by Stamen Maps, is a map base layer design that omits most information except the basic lines and features of a city, presenting it in black and white in a format designed for data mashups to be overlayed without extra map clutter. (Rodenbeck, 2012). The design fits the design principles espoused by Tufte (1990), Harrower *et al.* (1997) and Nivala et al. (2008) due to its clean design. Furthermore, the map design was compatible with the heatmap.js library by making use of the Stamen Maps API[13].

It was decided that this design was sufficiently different to the Google Maps design that users would be able to distinguish between them in a user study and be able to make a clear decision about which map base layer design they preferred under a heat map, thus giving insight into user preference and addressing the research question.

3.1.3 Design Choice 3: Colour selection

The heatmap.js library presents the opportunity to customise colours (hues) and opacity when generating a map. As the default colours in the library create a heat map covering the full electromagnetic spectrum from violet to red, a combination not recommended due to the order not necessarily being apparent (MacEachren, 1994), it was decided to test the default colours (see figure 3.1.3a) against another set of recommended colours for screen map design in order to gauge whether MacEachren's (1994) warning against using the full spectral range is still current today, when users are potentially more used to seeing online maps where the red end of the spectrum indicates a higher value (hot) and the violet end indicates a lower value (hot). The default colours in heatmap.js, and the maps featuring these colours, will be referred to throughout this report as the 'hue' colour combination.

[13] http://maps.stamen.com

Figure 3.1.3a: Default 'hue' combination on a Google base layer map

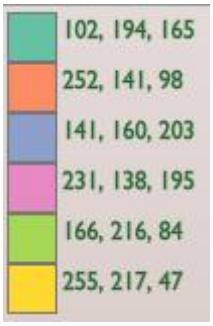
The ColorBrewer tool (Harrower and Brewer, 2003) was used to suggest colour combinations for the project's heat maps of restaurant data. To test and choose which colour sets to use, random data was generated using a Microsoft Excel spreadsheet and then test heat maps were created over the Stamen Toner and Google Maps base layers using each set of colours recommended by ColorBrewer.

The trial maps using ColorBrewer sets for ordinal data on choropleth maps, with many of the single-hue colour sets suggested by ColorBrewer not providing enough of a clear distinction between the different data classes, and the heat maps appearing almost as inky smudges, particularly in the blue and red colour sets (see figure 3.1.3a). This is the problem described by Brewer herself as 'simultaneous contrast' (Brewer, 1997; Harrower and Brewer, 2003), where colours surrounded by similar ones 'will more likely appear the same colour' (Harrower and Brewer, 2003).

Figure 3.1.3b: Simultaneous contrast on a test map

Though the test data on the map was arranged in ordinal classes (very hot, hot, medium, cold, very cold), due to the problems encountered with simultaneous contrast, it was decided to test all the ColorBrewer sets to see if any other combinations suited the map design. One of the ColorBrewer sets intended for qualitative data classes with no inherent order (Set2, figure 3.1.3b) created a multi-hued heat map with the colours used increasing in colour value – whereby high-value colours are lighter, here, yellow, and low-value colours are darker, here, dark blue (MacEachren, 1994). Though this combination is not recommended for ordinal data in Harrower and Brewer (2003), the result was an aesthetically pleasing map that could be tested as an alternative to Google Pin maps, therefore fulfilling the aims of the research and potentially gaining insight into user responses and or satisfaction with ColorBrewer schemes not originally designed for use with ordinal data.

Figure 3.1.3a: ColorBrewer Set2 colour scheme

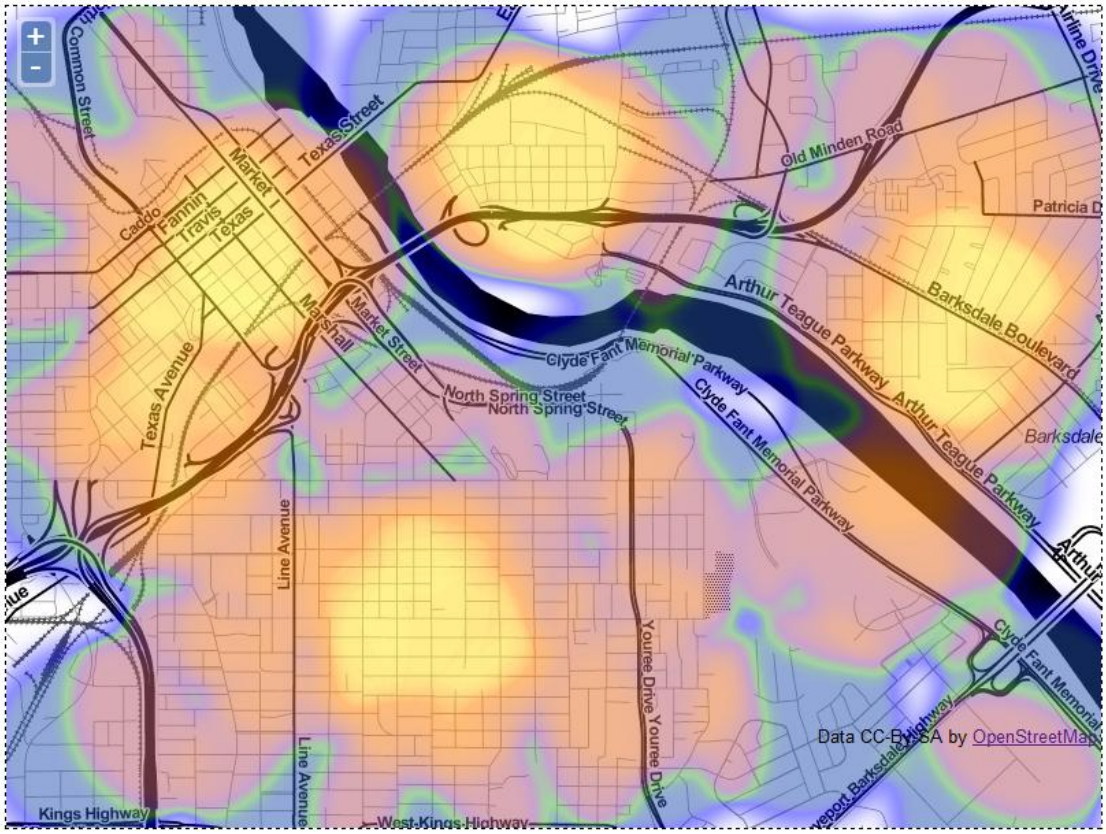


3.1.4 Spotlighting

Along with its pleasing aesthetics on screen, the ColorBrewer Set2, with its lightest colour in the 'hottest' areas of the map, also provided an opportunity to test user responses to the concept of 'spotlighting' proposed by Dykes and Mountain (2003), where colour lightness is used to draw the map reader's attention to the sections of the map with the most data or 'heat', as though a spotlight is shone on the most dense areas. It was decided that technique was worth testing and could be appropriate for maps of restaurant density as it draws their eye quickly to the areas on the map that could be attractive to them, and thus provided a potentially better user experience. See figure 3.1.4a for an example map.

Given that websites are almost uniformly using the Google Pin style of online travel map, testing such concepts and alternative map designs not only fulfils the research aims of finding effective alternatives but also could form future guidelines for the design of travel maps on the Guardian website.

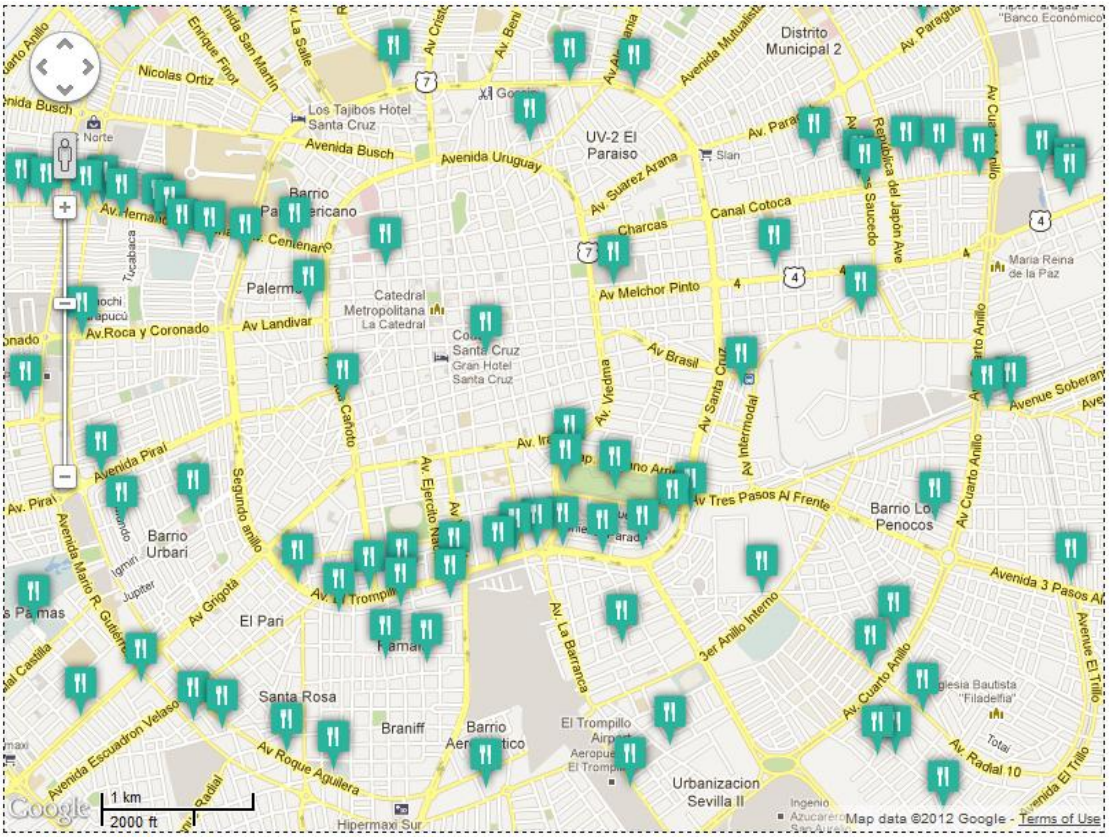
Figure 3.1.4a: Spotlighting demonstrated on a Stamen base layer



3.1.5 Design Choice 5: Pin maps

In order to test the alternative designs against the traditional Google Pin map style used on the Guardian website, a series of Pin maps were created using both the Google and Stamen base layers. These were created using the same image used for pins on the Guardian site, in order to make the maps look as close as possible to the original Guardian maps and ensure that the results were applicable to the Guardian website. Figure 3.1.5a shows an example of the Google pin control style, with Guardian pins. These were developed using a tool created by the researcher (http://www.student.city.ac.uk/~abkc668/mapping/mapmarkers-lusaka-stamen.html) using JavaScript to add map markers to the map, while providing a list of the Longitude/Latitude points of the markers in order to generate an identical heat map from the points.

Figure 3.1.5a: Google pin style map



3.1.6 Final list of map variables to test

After the initial prototyping and developing of maps, the final list of map variables to test was as follows:

Table 3.1.6a: Variables to test in online study

Variable 1: MAP BASE LAYER	**Variable 2**	**Variable 3**	**Variable 4**
Google Maps	Heat Map (regular hue)	Heat Map (spotlight design)	Pins
Stamen Toner	Heat Map (regular hue)	Heat Map (spotlight design)	Pins

3.2 Study design

In order to test the alternative map designs, an online study was designed. An online survey was deemed an appropriate and efficient way of testing user responses because of its ability to reach a number of users around the world efficiently and quickly, enabling a broader sample than would be possible with testing conducted in person (Oates, 2006).

Survey Gizmo[14], an online survey and questionnaire app, was selected as an appropriate tool with which to easily survey a large number of users across the world, and extract the data easily. It was chosen above other online tools such as the widely used Survey Monkey[15] and Fluid Surveys[16], as its free student accounts allowed greater flexibility with the layout (CSS) design of the survey's web page than that of rival services, which was important in designing a survey in which user perception and opinions of visual effectiveness were being tested (ESRC, 2009).

To answer the research question and discover if any of the variables were more effective or preferred by users, it was decided that all variables (see table 3.1.6a) should be tested against each other, with a maximum of two variables in each test.

The study was designed in nine parts, with each respondent only seeing one part of the survey. This decision was made so that participants were only exposed to two map variables, so that their opinions of the maps were not biased by what they had seen before. See the below table of variables tested in each group.

[14] www.surveygizmo.com
[15] www.surveymonkey.com
[16] www.fluidsurveys.com

TABLE 3.2a: Map designs tested against each other

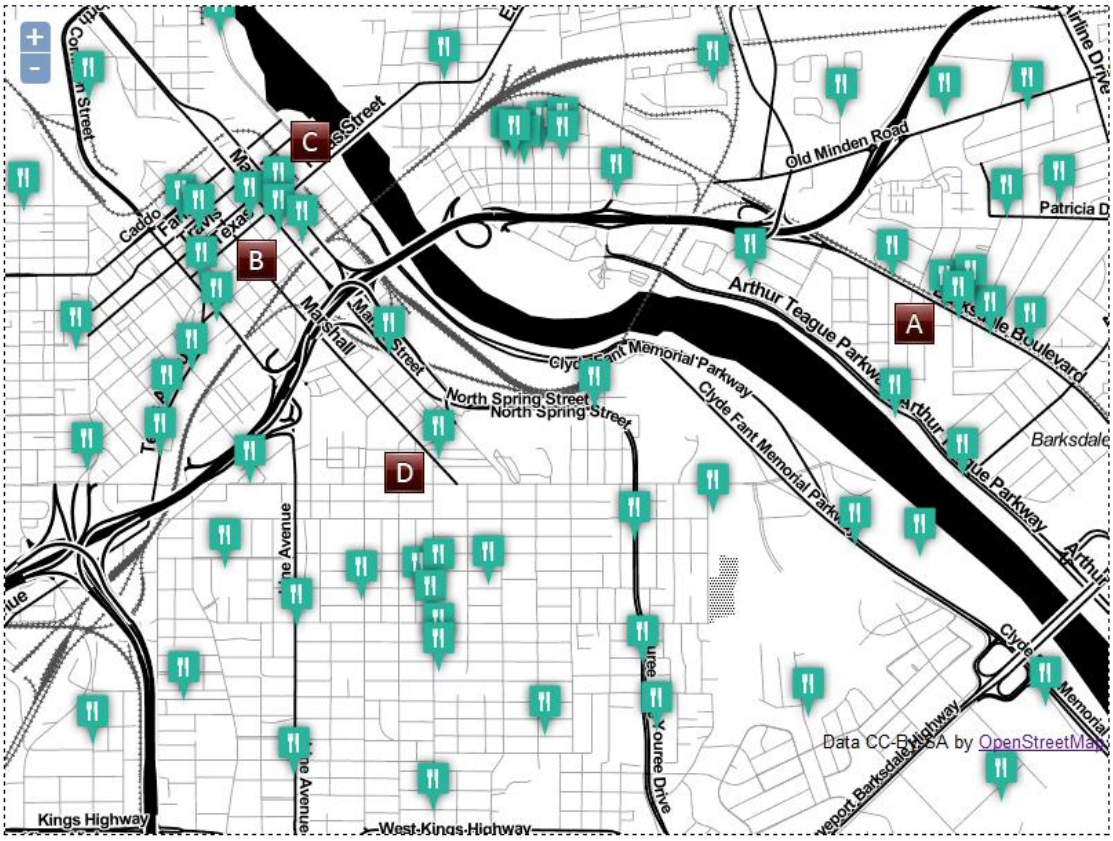
	Google Map Heat Hue (GMH)	**Google Map Spotlight (GMS)**	**Google Map Pins (GMP)**	**Toner Map Heat Hue (TMH)**	**Toner Map Spotlight (TMS)**	**Toner Map Pins (TMP)**
Google Map Heat Hue (GMH)		Group 6	Group 4	Group 2		
Google Map Spotlight (GMS)	Group 6		Group 5		Group 3	
Google Map Pins (GMP)	Group 4	Group 5				Group 1
Toner Map Heat Hue (TMH)	Group 2				Group 9	Group 7
Toner Map Spotlight (TMS)		Group 3		Group 9		Group 8
Toner Map Pins (TMP)			Group 1	Group 7	Group 8	

3.2.1 Study scenarios and questions

The study was designed with four parts asking different things of the user, in order to test the preferences and behaviour of each user:

Part one, on three separate pages, showed the user a map on each page. Each map had a series of icons marked A, B, C, D, where each icon was representative of an imaginary hotel, as well as the restaurant data visualised as per the variable shown to that group of users. The maps, Map 1, Map 2 and Map 3, were the same for all groups in the survey, and represented the same restaurant data presented in the different ways. See figure 3.2.1a for an example map.

Figure 3.2.1a: Example hotel-choosing task map, with Toner map and pins



Participants were asked to consider the map on each page and for each map were presented with the same scenario: '*Imagine that you are a person who enjoys dining and restaurants, and would like to be close to restaurants during your stay. Each map shows where restaurants are located across the city. Based on the map, choose which hotel (A, B, C or D) you would stay in, assuming all hotels are of equal quality and price'.* This question was adapted from scenarios posed in similarly conducted studies of user responses and experiences to maps by De Sabbata and Reichenbacher (2012) and Nivala *et al.* (2008). This scenario was chosen because it replicated a real-world decision-making process that the user would be making using a website such as the Guardian Travel website.

Maps created for this question were created using the methods discussed in part two of this report. All maps contained the same data. This ensured that each map presented exactly the same data for each map, and that participants in the study were seeing exactly a like-for-like scenario regardless of which map they saw.

Care was taken to ensure as much as possible that the cities chosen were not tourist destinations that survey respondents were not likely to have been to on a city break and were not covered as tourism hubs by websites such as Guardian Travel or Lonely Planet, but were large enough cities with enough geographical distribution to display

complex heat maps that looked as though they could be a feature of The Guardian's website.

Where labels on the maps chosen included name of the city, these labels were erased using image-editing software so that the city remained anonymous. Maps for this scenario were repeatedly generated using these techniques and the final set for the survey were chosen from a pool of 50, with the final three cities chosen for the study representing the most visually interesting maps in the pool, and with enough differences from each other so as to be distinct.

Consideration was also given to the placement of the icons A, B, C, D that represented the location of hotels in this decision-making task. Icons were put in the same place for the same city, regardless of map design. This was designed to test two things. Firstly, the consistency of responses of the participants. Did users choose the same hotel with a different map design across both maps? Or was this decision influenced by the design of the map itself, which could give insight into the effectiveness of the map design? Secondly, the hotel icons were deliberately placed between and within densely populated areas. This was designed to force participants to make a choice between similarly located hotels and see if they preferred being within a zone of restaurants or between two equally located areas of restaurants. This was also designed to detect if users had any strong preferences with relation to hotels that appeared to be in the centre of a city, and whether this changed depending on map design.

Maps were randomised for each participant, with some respondents seeing one set of maps before another despite being in the same group. This was to avoid the bias that came from having already seen a map design.

Part two of the study showed the participant one map design at a time (with a total of two maps being shown to each group) and asked the user to pick three adjectives from a group of 10 adjectives that best described the map. This experiment was designed to evaluate the effectiveness of the Guardian's current map design (in this case, the current design was represented by the Google Pin maps) against the proposed alternatives.

The adjectives were chosen from articles where the Guardian travel and or design teams had described their own maps (Lanyado *et al.,* 2012; Pietrasik, 2012). As these adjectives were self-described, negative adjectives, taken from Nivala *et al.*'s (2008) descriptions of poorly designed online maps were added to the group.

This was designed to show general user satisfaction with each design element that was being tested in the study, and see which combination of visual designs (map

base layers and heat or pin overlays, plus colour sets) was preferred by users, and therefore more likely to help them.

The order of adjectives was randomised for each participant (ESRC, 2009) so that users did not simply pick the top three adjectives.

Part three of the study showed participants an example of both maps side by side, and asked them to choose which was their preferred design. They were then asked which was the best for the hotel-choosing task, a question designed to test the effectiveness of the maps. Participants were then encouraged to give a an open-ended answer (Oates, 2006) allowing them to explain both decisions, in the the hope that this would give extra insight into user attitudes surrounding the map designs.

3.2.2 Pilot study

A pilot study was designed to test the robustness and question style of the study, and as an opportunity to gather preliminary data that could shed light on further questions to be asked in the main study.

The pilot study was limited to two variables but was conducted with 13 people in order to test the study as robustly as possible, and test that the SurveyGizmo program was capable of generated usable results data.

The pilot study revealed that SurveyGizmo's standard warnings to users if they did not answer a question were confusing and negative. Following on from the advice of the ESRC (2009), these warnings were rewritten so that users were encouraged to give answers in a positive fashion, not chastised if they did not.

3.2.3 Testing of final study

Prior to being sent out, the final online survey was tested across browsers and monitors. As described by Harrower and Brewer (2003), on the map images there were some differences in colour across monitors, however I decided that the differences were not substantial enough for the purposes of this project as it was testing not only colour but map design itself. Had it simply been colour that was being tested it would have been necessary to do all testing in person with the same monitor.

A problem with images was detected in the Safari for Mac browser. This problem was detected at a late stage in the development of the survey, so it was decided that participants using this browser would be excluded from the results as the problem appeared to be a bug with the SurveyGizmo program.

3.3 Recruitment and consent of participants

Participants were recruited by sending a link (http://tinyurl.com/citybreakmapping) A tinyurl, rather than the full SurveyGizmo link, was used to simplify the link for participants and reduce the risk of it being cut off in emails or similar.

The link was distributed among students completing the Research Methods module at City University London, as well as contacts of the author in the UK, Australia, Ireland, USA, Canada, Denmark, Netherlands and South Africa.

The wide distribution of the survey was to ensure that a variety of users participated and that results reflected the views of English-speaking internet users across the globe that were likely to be using the Guardian Travel website and similar online travel and tourism booking and information websites. The link was distributed via email, on online forums and on the social networking sites Facebook and Twitter.

Participants were also required to agree to a consent form that was included as the first page of the online survey; users were required to click 'submit' to accept the terms of the consent form and begin the survey. The consent form (see Appendix B) was adapted from the template suggested by City University London (2012).

4. Results

4.1 Participants

72 valid responses were received from participants, with eight responses in each of the nine groups. Above the 72 valid responses, there were 23 partial responses and 59 abandoned responses. Partial responses are defined as the survey respondent going past the start screen, but not completing the survey. Abandoned responses are where the participants clicked on the link but did not proceed past the first screen.

There were also a further 5 responses that were excluded from the valid responses due to the survey being undertaken on a Mac running Safari as the browser. As discussed in section 3.2.3, this was shown to have a bug when displaying images and it was therefore decided to exclude these results.

The survey was run until eight valid responses were received in each of the nine groups. The reasonably high overall number of participants reflected the need to break up the survey into nine groups, so that each user was not confronted with too many maps, leading to biased responses or the possibility of 'survey fatigue' (ESRC, 2009).

The high number of abandoned and partial responses may be a result of the survey being posted on social networks. It is a fairly recent trend for people to commonly access these sites on mobile phones. Such users could view doing a survey as a way to pass time on public transport or similar. However, with the large map images in the survey, it was required that users undertake the survey with a laptop, desktop or standard-sized tablet screen in order to view the images correctly, which meant that the questionnaire did not work properly for mobile users, leading to partial or abandoned responses. When testing the survey, it was not envisaged that so many people would access the survey on mobile phones, partly because the literature consulted (ESRC, 2009; Oates, 2006) is not yet up to date with mobile browsing habits. If future similar research is done, it is recommended that if the survey does not work on mobile devices, users are at least warned that this is the case in the introductory screen of the questionnaire, in order to prevent wasting users' time and capture more valid responses.

4.2 Part one – choice of hotel location

Part one asked participants to choose a hotel location on two sets of maps, first one design, then a second.

Each participant saw three maps with two different designs (six maps in total). Responses to maps with the same base level are recorded in the table below in a

style suggested by Tufte (2001) where the size of the font is relative to the size of the number of responses.

See Appendix C for the full responses to this question where users were asked to consider maps with different base layers.

Table 4.2.1: Number of times a hotel was chosen on each map design, GMH vs. GMP

hotel	GMH	GMP
A	-	-
B	7	1
C	-	-
D	1	7

Map 1

hotel	GMH	GMP
A	1	-
B	3	7
C	-	1
D	4	-

Map 2

hotel	GMH	GMP
A	1	-
B	-	2
C	1	1
D	6	5

Map 3

Table 4.2.2: Number of times a hotel was chosen on each map design, GMS vs. GMP

hotel	GMS	GMP
A	2	-
B	1	5
C	-	-
D	5	3

Map 1

hotel	GMS	GMP
A	-	-
B	5	7
C	3	1
D	-	-

Map 2

hotel	GMS	GMP
A	2	1
B	1	3
C	1	1
D	4	3

Map 3

Table 4.2.3: Number of times a hotel was chosen on each map design, GMS versus GMH

hotel	GMS	GMH
A	-	1
B	-	-
C	1	1
D	7	6

Map 1

hotel	GMS	GMH
A	-	-
B	6	5
C	2	3
D	-	-

Map 2

hotel	GMS	GMH
A	4	3
B	3	3
C	-	-
D	1	2

Map 3

Table 4.2.4: Number of times a hotel was chosen on each map design, TMH vs TMP

hotel	TMH	TMP
A	-	-
B	1	2
C	1	-
D	6	6

Map 1

hotel	TMH	TMP
A	-	1
B	4	2
C	3	5
D	1	-

Map 2

hotel	TMH	TMP
A	2	1
B	2	5
C	1	-
D	3	2

Map 3

Table 4.2.5: Number of times a hotel was chosen on each map design, TMS vs. TMP

hotel	TMS	TMP
A	-	1
B	2	-
C	1	-
D	5	7

hotel	TMS	TMP
A	-	-
B	6	8
C	1	-
D	1	-

hotel	TMS	TMP
A	2	2
B	3	6
C	1	-
D	2	-

Table 4.2.6: Number of times a hotel was chosen on each map design, TMH versus TMS

hotel	TMH	TMS
A	1	-
B	-	1
C	-	-
D	7	7

hotel	TMH	TMS
A	-	-
B	6	5
C	2	2
D	-	1

hotel	TMH	TMS
A	1	2
B	3	5
C	1	1
D	3	-

Map 1 **Map 2** **Map 3**

4.3 Part two – adjectives to describe maps

Part two of the survey asked participants to describe each of the two maps that they were presented with in turn by choosing three adjectives that best described the map.

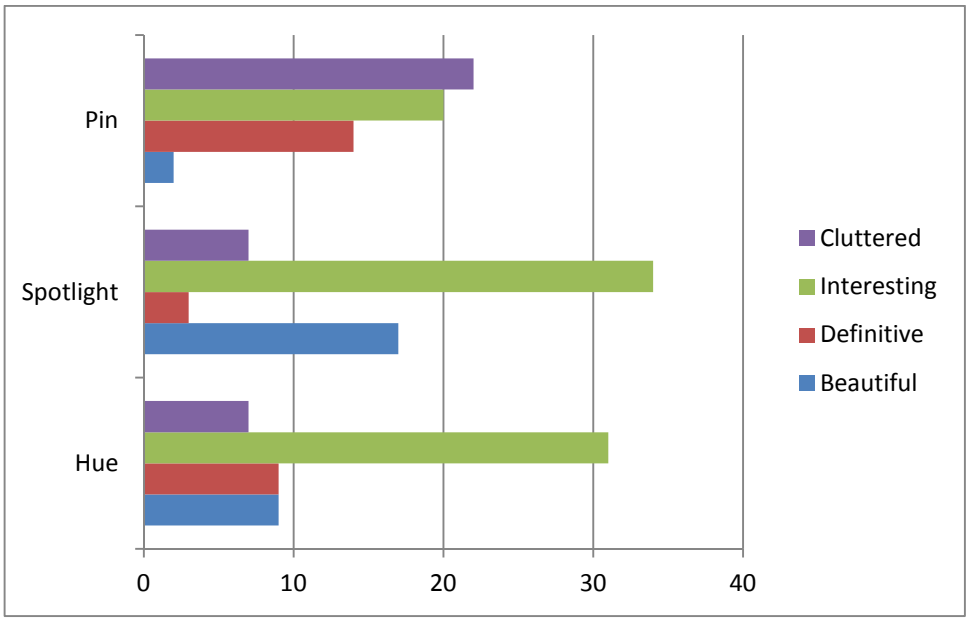
Table 4.3.1 shows the number of respondents that chose each adjective to describe a map design. Three groups saw each type of map, meaning 24 participants described each map design, with 72 responses overall.

Table 4.3.1 Frequency of adjectives used to describe the six map designs

	GMH	GMS	GMP	total Google	TMH	TMS	TMP	total Toner
Beautiful	3	8	2	13	6	9	0	15
Definitive	4	2	7	13	5	1	7	13
Interesting	15	17	11	43	16	17	9	42
Cluttered	6	3	9	18	1	4	13	18
Clear	12	10	14	36	16	14	12	42
Authoritative	1	0	3	4	3	0	5	8
Helpful	15	15	16	46	14	14	14	42
Inspiring	2	3	2	7	3	2	0	5
Unclear	7	10	4	21	5	5	6	16
Unhelpful	7	4	4	15	3	6	6	15

The results can also be split by map overlay design: pin, heat hue map and spotlighting. Figure 4.3.2 shows the frequency distribution of four key adjectives used to describe these maps, ignoring which map base layer was used.

Figure 4.3.2 Frequency of adjectives used to describe the three key map overlay variables



4.4 Part three – overall preference of map design

Part three presented the two map designs seen by each group and asked the questions '*Which map do you prefer?*' ('overall prefence') and '*Which map did you find best for helping you with the hotel-choosing task?*' ('best for task').

Participants were also encouraged to give a written answer to their reasoning for choosing either map in both questions. See appendix XX for the full table of written responses. Despite the fact that written answers were not compulsory, of the 72 responses, only two did not give written answers. This is a high number of responses that can in part be attributed to the positive phrasing of the SurveyGizmo warning as described in section 3.2.2.

Table 4.4.1: Overall map preference by group

	group 1	group 2	group 3	group 4	group 5	group 6	group 7	group 8	group 9
GMH		3		3		5			
GMS			1		5	3			
GMP	7			5	3				
TMH		5					5		4
TMS			7					1	4
TMP	1						3	7	

Table 4.4.2: Map 'best' for the hotel-choosing task by group

group 1	group 2	group 3	group 4	group 5	group 6	group 7	group 8	group 9

GMH		4		3		5			
GMS			4		3	3			
GMP	7			5	5				
TMH		4					4		5
TMS			4					4	3
TMP	1						4	4	

Tables 4.4.1 and 4.4.2 above show the overall results for each map pair by group, while tables 4.4.3–4.4.5 break the results down into separate variables.

Table 4.4.3: Frequency of preference for each base map layer (all groups)

	Overall preferred	Best for task
Google Maps	35	39
Toner	37	33

Table 4.4.4 below shows the number of times a base layer was chosen, excluding those tests where the same base layer was tested, e.g. GMS versus GMP. This table therefore refers only to groups 1, 2 and 3.

Table 4.4.4: Frequency of preference for base map layer when both map layers were tested against each other (groups 1, 2, 3)

	Overall preferred	Best for task
Google Maps	11	15
Toner	13	9

Table 4.4.5 below shows the number of times a map design variable (pins, spotlight or hue) was chosen, excluding those tests where the same variable was tested, e.g. GMP versus TMP. This table therefore refers only to groups 4–9.

Table 4.4.5: Frequency of preference for map design, excluding tests where the map design variable was the same (groups 4–9)

	Overall preferred	Best for task
Pin	18	18
Spotlight	13	13
Hue	17	17

5. Discussion

The results for each separate task provide a number of insights into user preference for map base layer and map overlay design. This discussion will address each design element in turn in order to make design recommendations.

5.1 Map base layer: Google Maps or Toner?

There was no clear preference among users for either the Google map or Toner map design. However, with the frequency of overall user preference for the Toner design surpassing or almost equal to the preference for Google Maps (see table 4.4.2), user opinion is divided and the Toner map has been shown to be a potential replacement for a Google Maps base layer in an online travel guide setting.

5.1.1 Adjectives used to describe Google and Toner maps

Perceptions of the Google Map design, probably recognised by most users as the current standard design in online travel mapping, varied depending on the task. When asked to judge the map designs based on adjectives used by The Guardian to describe their own Google Map pin design (see table 4.3.1), Google Maps were more frequently described as 'helpful', 'interesting' (although it must be noted that 'interesting' was the most frequently used adjective to describe all maps tested in the task and therefore may simply refer to the fact that the user finds *maps in general* interesting, rather than the Google Map design) and 'inspiring' (similarly but at the other end of the spectrum, this was not a common response so may not be a reliable description of the Google Maps base layer but rather of the overlay design and should therefore be discounted). Conversely, the Google Maps were less frequently described than the Toner maps as being 'beautiful', 'clear' and 'authoritative'. From the group of descriptions with negative connotations, the Google Maps were more frequently described as 'unclear' than the Toner maps. While looking at the overall perceptions of map base layers that were tested with different overlay maps could be misleading, these results do show that the alternative Toner design is preferred by users when 'beauty' and 'clarity' are the important factors, thus fulfilling Brown's hope that maps specifically designed for online travel websites would be 'attractive' (Brown, 2001), and Nivala's requirements that maps be 'simple' (Nivala *et al.*, 2008).

5.1.2 Familiarity with Google Maps

The adjectives chosen by participants in part two to describe the map designs are supported by the comments of participants in part three, where they were asked to justify their choice of most preferred map and 'best for task' map. Participants who stated an overall preference for the Google Maps described them as familiar (see

Appendix D), preferring them *'Because it's Google'*, *'More like what I'm used to seeing'*, *'The style of map is what I use in life, and the locations and distance are very clear including the trafic* [sic]' and *'Map A* [GMP] *is a more "traditional" map which is easy to read'*. These descriptions are consistent with the adjectives used to describe the Google Maps in part two ('helpful', 'interesting'). When presented with both a Google and a Toner map design, some respondents commented that (despite the fact that the maps were intended as an overview only), they liked to have a lot of information on a map in order to make travel planning decisions, and that Google was better for this type of person: *'Using Map A* [GMS] *gives me a greater sense of reassurance in choosing a hotel that guarantees a variety of choice in the hotel's vicinity should I have no internet access or reliable source to check with on places to eat at, especially if I go exploring or wandering around the neighbourhood',* and *'More landmarks and information on the map'*.

It is therefore clear that survey participants had a higher level of familiarity with the Google Map design than the Toner map design, and that this influenced some responses. However, the results were mixed. On overall map preference rankings when the two maps were compared with each other, Toner maps received more votes (13) than Google Maps (11) from the 24 respondents who were given this combination of map designs (see Table 4.4.4).

The comments from those who preferred the Toner map design were also consistent with the responses given when asked to choose adjectives ('beautiful', 'clear'). Participants who liked the Toner maps commented that the simpler white Toner design was *'Easier to understand'*, 'Easier to read', 'Clearer and more defined' and that the *'Streets are clearer'*, allowing you to *'… see the layout of the city much more clearly'*. This result shows that for some users, the Toner map is preferred and with more testing and development could be an effective alternative to Google Maps in future online Map designs for the Guardian or similar travel sites.

5.1.3 Base layers and the needs of the user

The results to part three also indicate that there was sometimes a difference between the map that participants preferred overall and the map that participants felt best helped them with the hotel-choosing task. While 11 participants chose a Google base layer and 13 a Toner base layer as their preferred map, when asked which map was best for the task, 15 responded that Google was preferred with only 9 choosing Toner (see Table 4.4.4). While these results should be viewed with caution as it is a small group of participants and participants were also influenced by the map overlay design they saw, the open-ended answers given by participants (see Appendix D) reveal their different information needs and indicate that further research could be undertaken as to what types of map users prefer for certain tasks. One user who preferred the Toner map overall commented that they chose the

Google Map for the hotel-choosing task because *'Distance is the key piece of information for that task, so the fact that Map A* [GMS] *shows distance'*. This shows that a task such as picking a hotel can be interpreted in different ways by different participants, and that this user wanted to know exact distances in order to make a decision, which the Google Map was better at showing, either through landmarks or because the participant was more used to judging distances on Google Maps and could take cues from design elements such as font size and the number of features at a map of that scale level.

Such responses reflect the situation that different users have different information needs, and that this must be taken into consideration when designing maps for online travel sites. The fact that participants were almost divided over whether Toner or Google Maps were best overall and for the task indicates that deciding on which map base layer is an important decision to be made when designing such maps.

5.2 Map visualisation: heat map or pins?

As with the results for map base layers, user opinions about the overlay visualisation (heat map with hue colours, heat map with spotlighting colours or pins) were divided. When users were asked in part three which map they preferred, results for each of the visualisations were almost equal, with pins being preferred 18 times to the hue heat map's 17 times, and spotlighting map 13 times (See table 4.4.5, excluding those groups where visualisations were tested against themselves). Results for the 'best for task' question remained constant, with users only changing map base layer designs in this question, not the visualisation type. It must be noted that such an even result for the three groups could indicate that the participants did not like any of the maps and because they were forced to choose one as their preferred map, the results may be biased in some way. This is reflected in the comments of a small number of participants, for example when one respondent was asked which map was best for the hotel choosing task, he or she stated *'Neither really. For that they seem the same to me.'*

However, the positive response – in numbers and in written answers – of many respondents to the heat map design indicates that, while tested on a relatively small group of users, the design could be an effective alternative for a Google pin map for users in the pre-planning stages of a holiday: *'[…] for a general overview of the city layout it is much easier with map B [GMH]'*, *'It is much easier to discern the restaurant districts in the second map. I didn't always choose the hotel located in a restaurant district but sometimes one within a short distance of two or more.'* and *'It's easier and clearer to read the information quickly [than the Google map]'.*

5.2.1 Influence of map visualisation on user decision-making

Task one, where users were asked to choose hotel locations on one set of maps, then repeat the task on the same set of maps with a different visualisation, was designed to test the hypothesis that map design could influence user decision making. This hypothesis, if proved to be correct, could have implications for travel map design from a commercial as well as a usability perspective.

As shown in tables 4.2.1 to 4.2.6, user responses did vary, sometimes significantly, when the map visualisation style (pins, heat map with hue colouring or heat map with spotlighting) was varied and the map base layer (Google Maps or Toner) remained constant. While some results should be read with caution as it may simply reflect a personality trait in some participants, i.e. that they are indecisive or likely to change their minds quickly, two tests can be read as showing a significant difference in the hotels that users chose on each map.

When Google Maps spotlight (GMS) was tested against Google Maps pin (GMS), on map 1 users were most likely to choose hotel D (see table of results 4.2.2 and map figure 5.2.1.1), probably because it is a hotel directly in the brightest area of yellow (meaning a high concentration of restaurants. When users were shown the same map with the same data, but visualised in the GMP style, users were more likely to choose hotel B. On this map (see figure 5.2.1.2), figure B is in the central-most position, between two clusters of hotels to the east and west.

Figure 5.2.1.1: GMS map 1 from part one of the survey

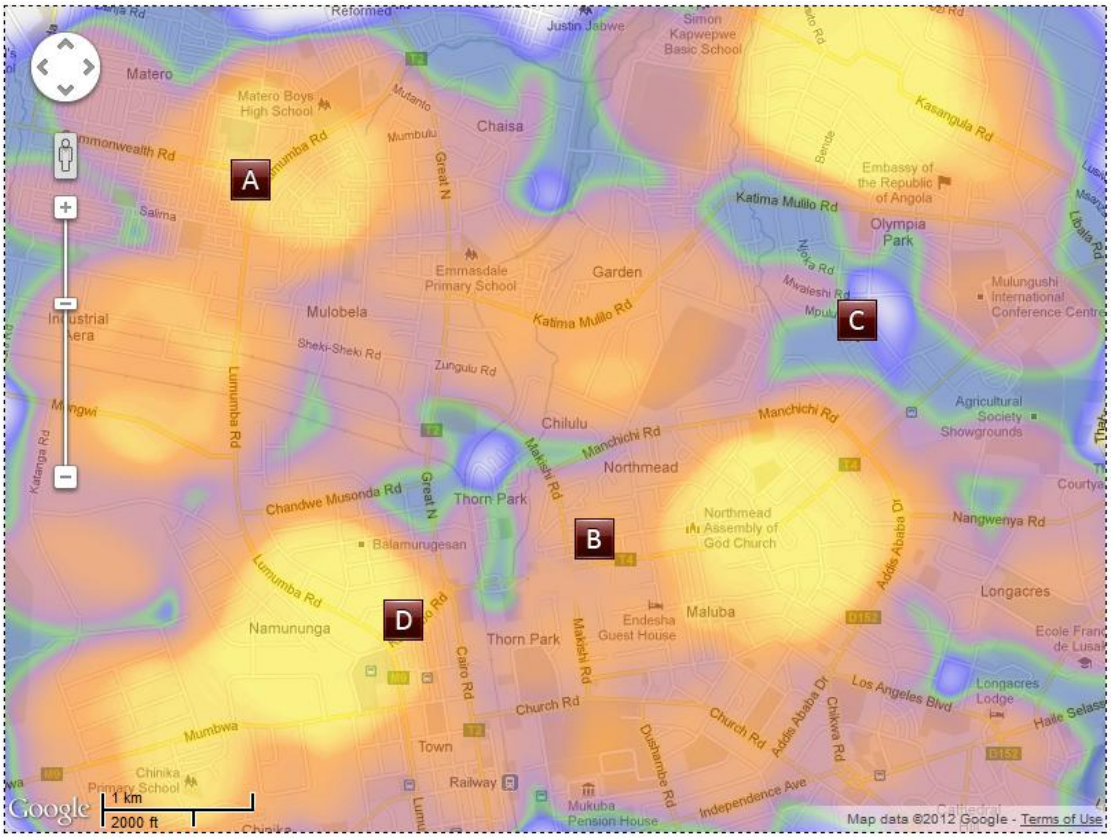
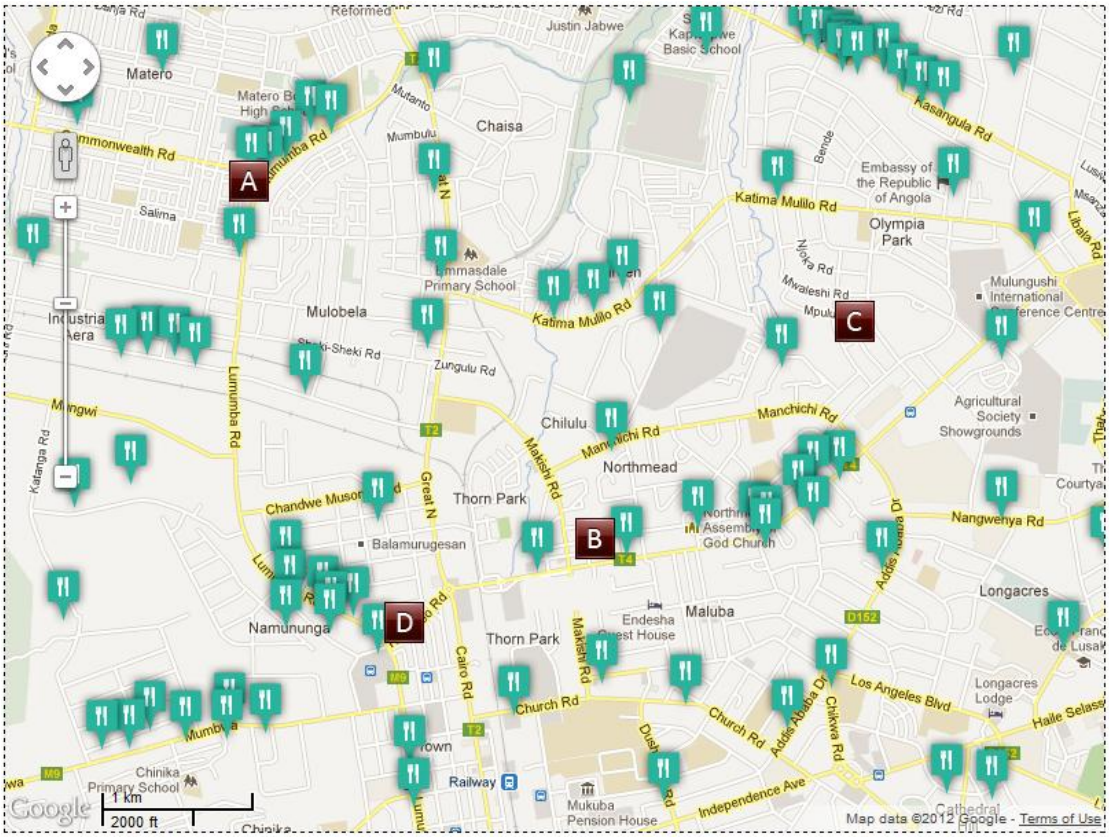


Figure 5.2.1.2: GMP map 1 from part one of the survey



Similar results were seen when shown the Toner map with spotlight (TMS) and the Toner map with pins (TMP). On TMS map 3 (see figure 5.2.1.3), hotels were deliberately arranged so that the only hotel clearly within a hotspot on the heat map was in the top right of the map. Because of this, there was no clear preference between hotels, with an almost even spread between choices (see table 4.2.5). On the TMP map, however, respondents were more likely to choose hotel B, the hotel in the centre of the map, again situated between two clusters of restaurants to the north and south of the hotel.

Figure 5.2.1.3: TMS map 3 from part one of the survey

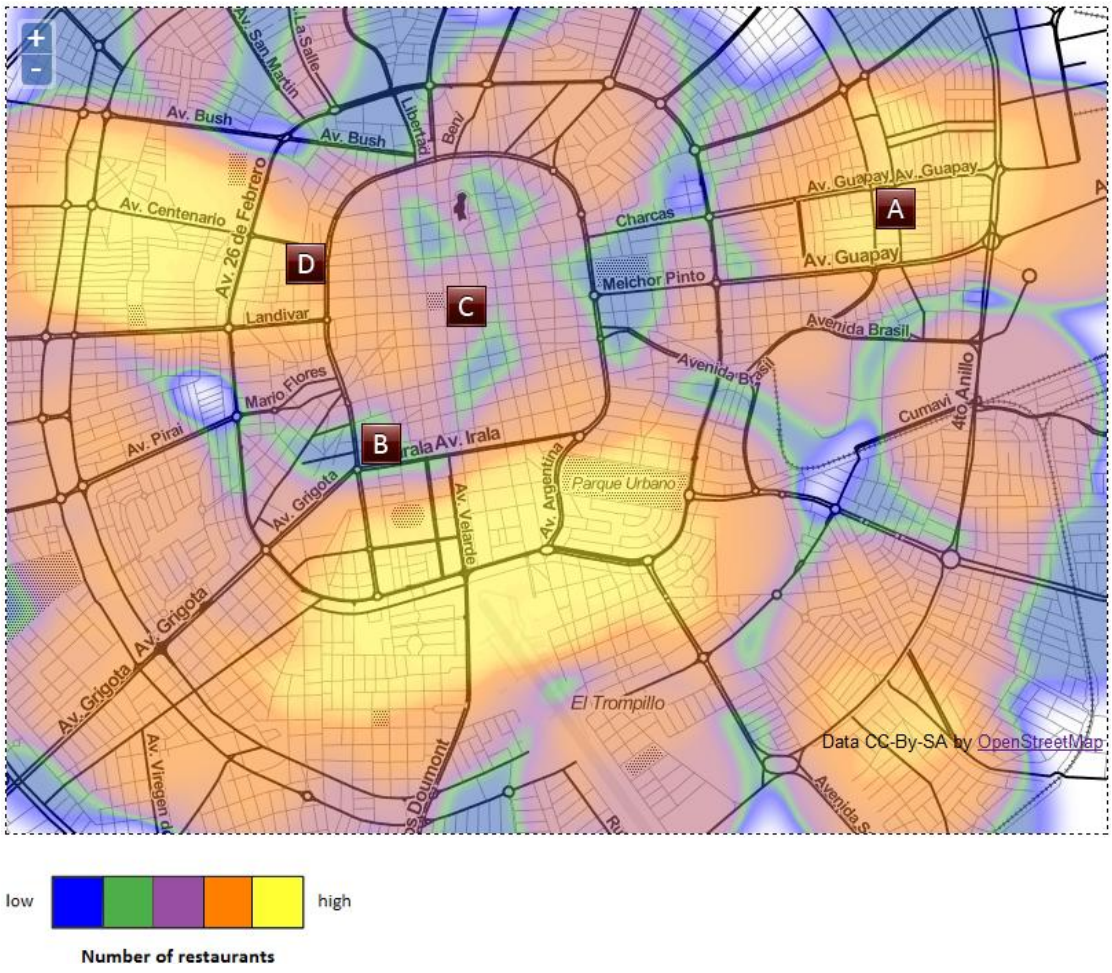


Figure 5.2.1.4: TMP map 3 from part one of the survey

Comparable results were also shown for hue maps versus pin maps, when GMH was tested against GMP (see table 4.2.1).

The results for both sets of maps show that users are more likely to choose hotspots on the heat maps (whether spotlight design or hue) but on pin maps, with their more uniform colour design, users are more likely to be detecting patterns or quite simply choosing the hotel in the centre of the map. While it seems that users are drawn to the colour of the heat maps (as one participant put it, *'It is much easier to discern the restaurant districts* [in the heat map]*'*, on pin maps, with their more uniform colour design, users were more likely to make decisions based on distance, and even distance between clusters, a phenomenon best described by Ware (2004) in his discussion of spatial proximity in data visualisation.

Because it is only possible to compare the responses from single groups of eight in the hotel-choosing task rather than the overall responses, the numbers in the results analysed for this task are quite small and therefore could possibly be proven as unreliable if a larger study were to be conducted. However, the results of this study indicate that more research could be beneficial to further our understanding of the influences on individual choice when looking at such maps. This finding relates to the *effectiveness* of the heat map design because it shows that users are interested in, can read and are possibly satisfied with decisions made using these maps.

5.2.2 Heat map colour and spotlighting

As with the results for map base layers, here there was a difference between the maps that participants 'liked' and the maps that they thought best for the hotel-choosing task. When participants were asked to use adjectives to describe the maps, users were most likely to describe the Spotlight maps as 'beautiful' and 'interesting', followed by the Hue maps and lastly the pin maps (see figures 4.3.2 and 4.3.3). This attitude was confirmed by some respondents in the freeform answer section, describing the spotlight maps as *'softer and easier on the eye'*, *'*[I] *prefer the colours'* and *'*[…I] *Like the heat map idea better in this colour scheme'*.

However, when asked to choose the maps preferred overall and the maps best for the hotel-choosing task, the spotlight maps performed the worst overall (see table 4.4.5). This could be linked with a lack of familiarity with the colour scheme as opposed to the more traditional hue scheme used on the hue maps, or it could be that users simply did not understand the colour scheme as it does not fit with the schemes recommended by MacEachren (1994) or Harrower and Brewer (2003) for ordinal data. Or, the results may simply reflect a weakness in the design of the maps – the spotlight scheme does clash with the default colour scheme of the Google Map design, and this could have affected the way in which respondents perceived it.

It must also be noted that this study did not make any allowances for users with possible colour blindness and that this may have contributed to some unreliable results related to colour. Future studies would be wise to screen out colourblind respondents from participating, or adapting the study so that their results were in a separate group to non-colourblind users.

5.3 Recommendations for map design

As discussed in section 5.1, it is suggested that designers of online maps evaluate the needs of the user before choosing an online map base layer design. Does familiarity with the design or the ability to perceive distance matter (in which case Google Maps might be preferable), or would a simpler design (such as the Toner design) be useful in order to place more emphasis on the data displayed on the map?

Once the decision of map base layer has been made, it is suggested that a suitable overlay combination – heat map (hue) or pins for Google maps, heat maps with hue or spotlight designs for Toner maps, be chosen depending on what is required – precision, or an overview.

6. Conclusion

This project aimed to investigate the effectiveness of the existing map design used on the Guardian travel websites and compared it with two different heat mapping techniques. It has shown that the alternative mapping techniques can be effective and viewed positively among users when compared with the Google pin maps, although there was no overall 'best' map design chosen by the participants in the study.

The research also generated some design guidelines for online travel guides, which may be of use to future researchers and online cartographers, although these recommendations must be taken with caution due to the sample size and possible biases of the study.

It is recommended that further research be undertaken, particularly with regards to developing the code required to generate complex heat maps. The fact that this researcher is not a trained cartographer was not ideal and was a flaw in the research process. If a researcher trained in producing maps were to generate heat maps similar to those produced in this study, the results would be more reliable.

Another limitation of this study was the use of the hotel and restaurant metaphor for the maps. Although users were asked to 'imagine' they were keen on dining out, some users stated that they were not and may therefore have used other factors in making decisions about their hotel choices. In future iterations of this research it might be prudent to use a different type of data in the heat maps in order to avoid this kind of bias.

It would also be beneficial to conduct future research on the way that map design influences user decision-making process as shown in the hotel-choosing task. This was not the main focus of this study, merely a hypothesis drawn from it, and the sample size in this section of the study too small to draw solid conclusions. However, the same task conducted among a larger group, and as the main focus of a future study, could show the same outcomes and be useful for commercial or usability applications.

It was proposed originally (see the project proposal, Appendix A) to conduct a further user-testing study among a panel of Guardian Travel readers to gain further insight in the needs and behaviour of users, which would have taken the form of a think-aloud test common to the field of user experience and interaction design research. This element of the research was abandoned for reasons of time and also because the eventual online study was designed in a more comprehensive manner than originally proposed, thus providing enough data for a project of this size. If future work is to be done on this topic, it is also recommended that a live user test

such as the one described in the proposal be designed and carried out in order to gain more insight into *why* people make such decisions and how online travel maps can be better designed to give users an overview of an unknown city.

This study has gone some way to showing that, as one study participant remarked, *'you do get a little bored with the same old style of map'* (Appendix D) and that users are able to make effective decisions with travel maps designed as heat maps that might have future applications on online travel guides that require overview maps.

6.1 Personal reflection

I started off this project with a keen interest in but a lack of knowledge about online mapping, and a feeling that Google Maps might not always be the way to go. Along the way I learned a lot about mapping theory, colour theory and general GIS theory.

I was surprised with and pleased by the results, particularly the long-form answers that people took the trouble to give, which gave great insight into the behaviour and thoughts of the users I was trying to reach with the study.

I kept a very rough blog[17] throughout the process that served as a good way to remind myself what work I had done and what was required in the future, particularly as the project was conducted on a part-time basis. It was also useful for recording discussion with my supervisor so we didn't unwittingly discuss the same thing twice. The blog did not really help with the write-up of the report as it was a bit too rough, but it did help keep me on track.

I think, like many MSc students, I promised too much in the initial proposal but had to strip things back in the actual study because it became apparent that the time available to undertake the project was shorter than the time required to do everything, although the unrealised elements of my proposal could form the basis of future research.

[17] http://heatmapdissertationdiary.wordpress.com

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Appendices

Appendix A: Project proposal

Appendix B: Consent form

Appendix C: Results of online study

Appendix D: Open-ended responses table from online study