

# Investigating aesthetics to afford more ‘felt’ knowledge and ‘meaningful’ navigation interface designs

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**Abstract**—Aesthetically manipulating the visual variables of a navigation interface design has the potential for substantial improvements in the interpretation of, and subsequent navigational choices made resulting from that design. This paper reports on a study that explores how an ‘optimal’ path is understood across fifteen different types of route map designs for ten cities (approximately 150 route map designs in total). We are interested in how participants make sense of the route map, and subsequently choose an optimal pathway. The findings show that participants who experience certain aesthetically designed route maps are more inclined to meaningfully link information and create connections. By more deeply understanding people’s perceptions of the aesthetics of a navigation problem space – particularly the ways in which people value and connect with aesthetic elements and how these impact the decisions made – a novel insight into individuals’ understanding of data visualisation and how aesthetics affect is achieved.

**Index Terms**—aesthetics, HCI, visual variables, decision-making, felt knowledge, affect

## I. INTRODUCTION

The way information is displayed on an interface drastically changes our understanding of, and consequent decisions using, that information. With a few exceptions, data has no natural visualization so important choices have to be made about how it should be displayed. These choices involve not only how to convey the logical and operational dimension of knowledge, but also the directly felt, experiential dimension. As [1] pointed out, meaning is not only a certain logical structure, it also involves felt experiencing. This is particularly true when it comes to affording insight, [2] note that this can be improved by recording uncertainty along with data. Described as one of the most challenging aspects of visualization, research by [3] shows that visual variables (i.e. sketchiness, blur and others) can be used to effectively depict various levels of uncertainty in data visualisations. In this paper, we present a user study that explores aesthetically enhanced visual variables in navigation interface designs to trigger feelings of uncertainty and hence influence the path choices made. Specifically, participants were tasked to find the optimal path on a route map; these route maps were designed to afford aesthetic interactions and/or analytical interactions. By aesthetic interaction, we

simply mean the creative manipulation of visual variables (i.e. colour, tone, hue, blur, sketchiness, noise, scribble etc.) to sensually engage and emotionally influence the user in their choice of the optimal path. In contrast the analytical approach uses a more logical process to calculate the path (i.e. count values on the paths). We hypothesize that participants will choose the paths that are not or least uncertain (i.e. not/less blurry, not/less noisy, not/less sketchy etc.) and/ or the path with the lowest calculation. The study investigates whether there is a difference in perception between participants who aesthetically interact with certain visual variables to establish the optimal path compared to participants who use more analytical approaches. The outcomes of the paper aim to provide some insight into the potential of the aesthetic for navigation interfaces that require choices on safety and security to be made.

## II. AESTHETIC INTERACTION AND INTUITIVE SENSE MAKING

The ancient Greeks first described aesthetics as sensation – the ability to receive stimulation from one or more of our five bodily senses. Since then, it has had a long history across both the arts and sciences; the field of neuroaesthetics (first coined in 1999) is the latest field breathing new life into the debates on aesthetics. Chatterjee draws from both the sciences and the humanities to offer valuable insights into the aesthetic experience and how aesthetic can influence choices in important domains of human activity [4]. In the 1700’s Kant wrote about aesthetics as helping to create context and meaning in our reality; he felt that without aesthetics the world would become a chaotic mess of facts and data that don’t fit together and lack meaning and structure. He believed to have an aesthetic perspective meant to assemble knowledge fragments into something that has meaning. [5] identified four fundamental patterns of knowing that form the conceptual and syntactical structure of nursing knowledge. These four patterns include: personal, empirical, ethical, and aesthetic knowing. Aesthetic knowing takes all of the other ways of knowing and through it creates new understanding and perspective of

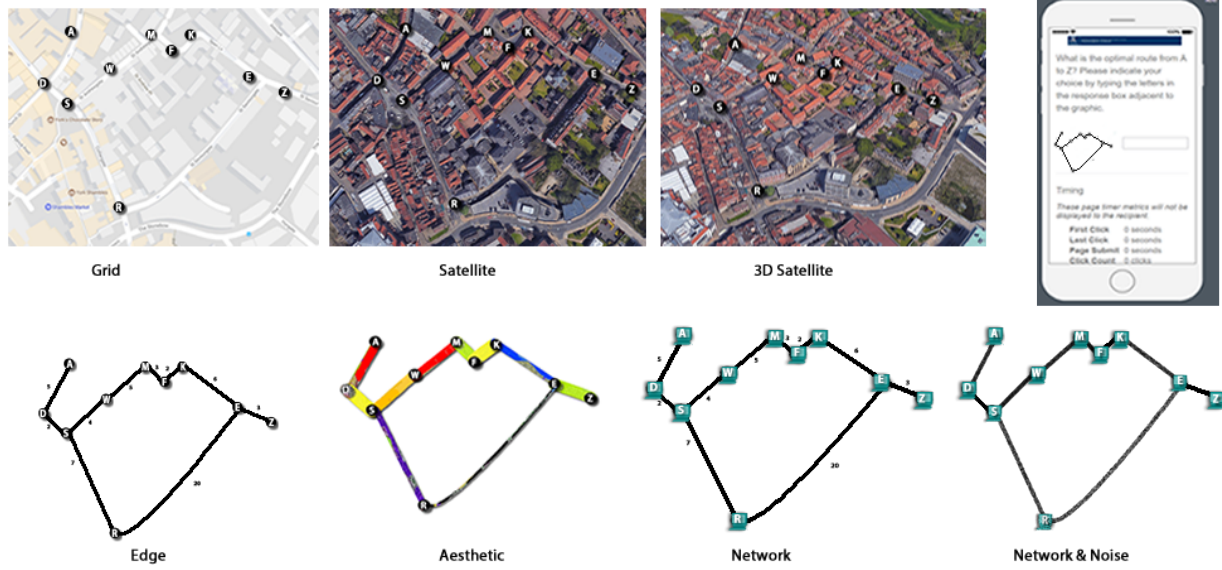


Fig. 1. Routemap designs for York city presented during study 1.

a phenomenon. As [6] notes ‘Aesthetic knowledge’ refers to sensory-derived (i.e. sight, hearing, touch, taste, smell and ‘gut feel’) tacit, non-rational, symbolic and experiential knowledge which emerges from people’s embodied sensory experience of, and embedded relationships with, phenomena. It is felt knowledge coming from an ‘engaged interaction’ between the person and the interface design. The ‘engaged interaction’ occurs through the senses when the information of the design combines and interacts with the information (i.e. knowledge, experience, memories etc.) of the person to create new and deeper meanings. We can initiate the ‘engaged interaction’ and hence the aesthetic knowledge through the use and groupings of different sensory elements [7]. Aesthetic design has the power to manipulate and enhance the perceptions of the person to make effective intuitive decisions [7]. There are situations in which decision makers arrive at an idea or a decision not by analytically inferring the solution, but by intuition – sensing the correct solution without being able to give reasons for it [8]. Intuition is an immediate, experience-based impression of coherence driven by cues in the environment [8]. Intuition arrives without reflection or rational thought and has been described as aiding decision making and problem solving. As [8] outline, intuition has an aspect of experientiality; it is felt knowledge that aids decision making, not only in cases in which the decision maker has experience with a particular situation, but also when time and cognitive capacity is limited.

### III. EXPERIMENT DESIGN

This research is divided in two parts; Study 1, documented in [9], explored the impact of aesthetically enhanced visual variables in a navigational problem space (i.e. route map). The study included seven different scenarios for six cities (three organically grown cities and three planned cities). These scenarios included grid, satellite, 3D satellite, edge, aesthetic

and network route map designs; thirty-six route map designs were used in total (See fig 1). The grid, satellite and 3D satellite route maps were picked to represent standard designs that we assumed all participants would be reasonably familiar with. The edge and network routemaps were designed to represent a more online route map scenario affording an analytical approach with weighted edges. This research is very much grounded around an interest in the field of situational awareness [10], particularly how we might adapt traditional real-world environmental cues to support the design of our online navigation. The aesthetic route map design focused on a combination of visual variables such as color, texture, line, noise, blur and scale and their aesthetic manipulation using a graffiti effect (i.e. graffiti is often associated with feelings of uncertainty in the physical world). This graffiti effect was achieved by applying standard Adobe Fireworks filters (i.e. Gaussian blur and uniform noise filters) in conjunction with layering and transparency techniques. Importantly, the design of this aesthetic route map along with the edge, network and other route maps was centred around an ‘optimal path’ (i.e. the quickest route) predicted for each city using Google Maps (see fig 3). The results of study 1 highlighted some potentially interesting affects amongst the participants whilst choosing their optimal path in the aesthetic route map design: ‘thinking about fastest way to get from a to z. looking at the cleanest route. I was drawn to the wider lines, brighter colours, route that felt faster overall.’

The second part of this research, Study 2, was designed to probe these affects further. By isolating the visual variables of the aesthetic route map design, the aim is to examine the impact (if any) of the individual visual variables on the optimal path choices made (see fig 2). We are interested in seeing whether there is a difference in perception between participants who aesthetically interact with certain visual variables to

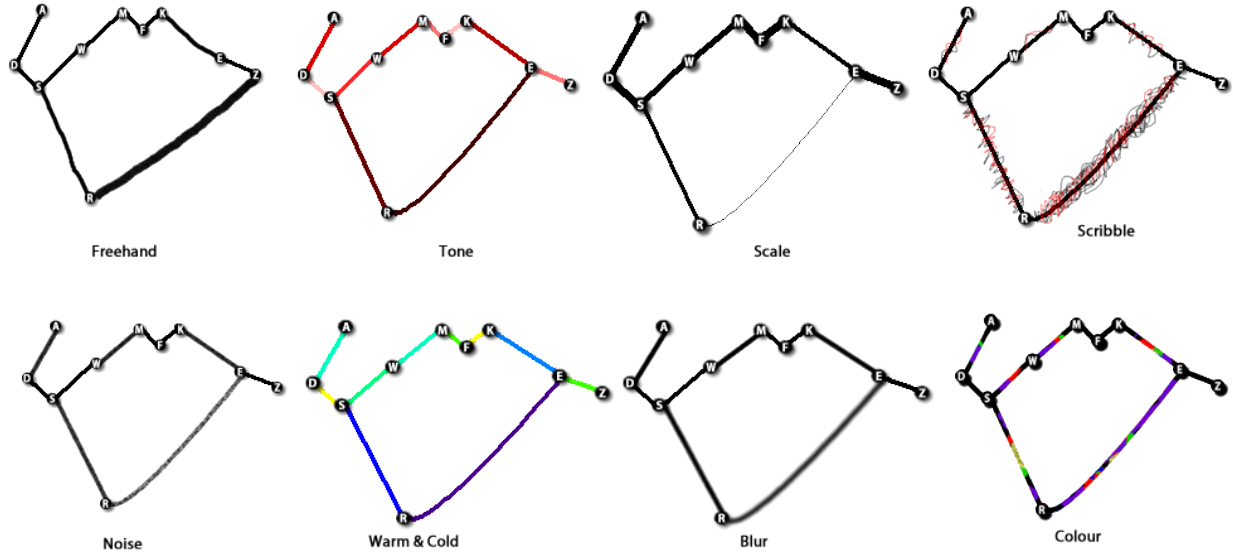


Fig. 2. Route map designs for York city isolating eight different visible variables.

establish the optimal path compared to participants who use more analytical approaches. Overall, study 2 consists fifteen different scenarios (including those that were used in study 1) for ten cities, hence one hundred and fifty static route map designs in total were used in this study. These scenarios include: grid, satellite, 3D satellite, edge, aesthetic, network, network noise, sketchiness, tone, scale, scribble, noise, hue, blur and colour route map designs. Again, all the non standard designs were statically generated using Adobe Fireworks CC software and the designs were based on an ‘optimal path’ (i.e. the quickest route) predicted for each city using Google Maps. Inspired by the visual variable groupings of [3] this study produced three visualisations under the colour-based technique category. These included: Colour (saturation and mixing of multiple colours), Tone (the lightness and darkness of a colour) and Hue (Warm Cold). Two visual variables under the focused based techniques: Noise and blur were explored. Finally, three geometry-based techniques were used including sketchiness, scale and scribble. As we can see in Figure 4, the visual variable of each of these route maps was carefully-designed in levels to match the weightings in the edge route map design. For blur, noise, tone and hue designs we used standard Adobe Fireworks blur, noise and colour filters.

The study was conducted at Melbourne University in spring 2018 and we were particularly interested in comparing participants perceptions whilst choosing the optimal path across all routemap designs. The study duration was approximately 60 minutes and one hundred and forty-eight psychology students, ranging from 18-30 years of age, took part. The Ethics Board of the University of Melbourne approved the experimental procedure and participants provided written consent for study completion and the academic use of de-identified data.

#### IV. DATA COLLECTION

The study was undertaken using the Qualtrics online survey software. Participants were presented with a series of 150 route map designs and were asked to find the optimal route through each map (from A to Z) and to subsequently clarify what they interpreted as optimal (i.e. they had to decide/ figure it out for them-selves). After each randomly presented set of route map visualizations for each city, participants were asked about the strategies they used for solving the problem, and the thoughts they experienced during it. These open-ended questions included: What strategies have you applied to enable you to determine the optimal route between A to Z?; In your opinion, what did the elements presented in this graphic mean?; What did you understand by the term optimal route? Did that understanding change across the different graphics?

After all the route map designs were presented, participants were asked to rank a sample of route maps from each set, in terms of: easiest to determine the optimal route between A to Z; most difficult to determine the optimal route between A to Z; and in order of preference. All participant data was securely collected using the Qualtrics software.

#### V. DATA ANALYSIS

The aim of this study was to more deeply investigate the differences across the different route map designs, and in doing so, to allow for flexibility to concentrate on specific areas of interest while also revealing other emerging areas. The following section highlights and discusses the results of the qualitative analysis of the data.

#### VI. RESULTS AND DISCUSSION

Participants’ rationales regarding their choice of pathway reflect both the use of analytic and gut-based reactions to the route maps which altered their approaches to the choices

they made. The qualitative data highlighted themes such as ‘analytical’, ‘intuitive’, ‘hybrid’, ‘embodied’, ‘random’ and ‘memory’ to represent the approach taken by the participants in choosing the ‘optimal’ path. In more detail, the analytical approach tended to involve the calculation of the optimal path (i.e. “route with the least amount of letters”; “counting to see the route with least intersections, letters and less bends”). The intuitive approach generally engaged the visual variable and the affordance of ‘gut’ feelings and emotions whilst choosing the path, with comments such as: “I started by adding up the distances, but after that, I decided to go back to my previous method of choosing which route appealed to me most”; “I chose the routes where I avoided lines that were more ‘fuzzy’ than the others, preferring the solid black lines”; “There are some lines not totally black, maybe they are not easy to go, so I choose those clear black lines”. The hybrid approach combined both analytical and intuitive: “easiest and most convenient route, straightest but most direct”; “The path with the least wobbly lines”; “The first route that stood out to me, the more uniform and normal looking paths”. Whilst the embodied approach saw participants put themselves into the map/ situation of finding the path: “I imagined I was walking the trip and didn’t go by traffic arrows, then just distance by measurement”; “I imagined myself driving and the map and used that to determine which route I would drive on”. Finally, participants using the memory approach drew on knowledge from previous attempts (i.e. “same as previous trials”; “same as before”; “the same as previously”) and the random approach encompassed totally unconnected choices (i.e. “by guessing”; “the first way I saw”; “the direction of the road”; “displacement”). When asked about the strategies that they had applied to enable them to determine the optimal route between A to Z? It is clear from Table 1 that analytical approaches were used more in the edge route map and more intuitive approaches were used in the aesthetic route map.

Interestingly, the words ‘numbers’, ‘distance’ and ‘time’

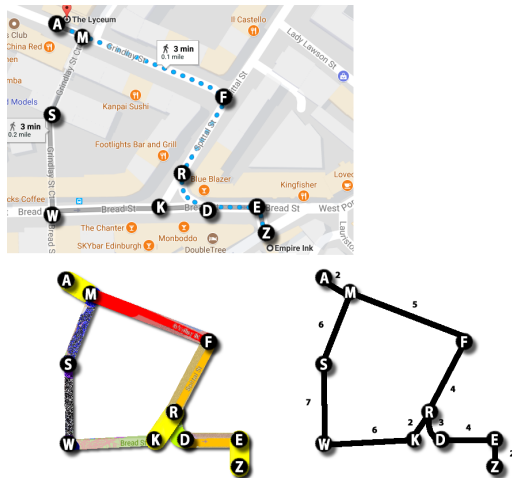


Fig. 3. Google maps predicted route informing design of optimal path Edinburgh city

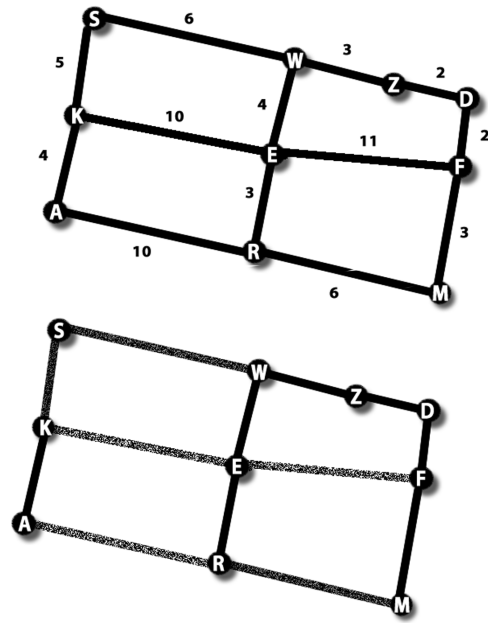


Fig. 4. The noise routemap has been designed with different levels of noise to correspond to the weighted values of the edge routemap Glasgow city.

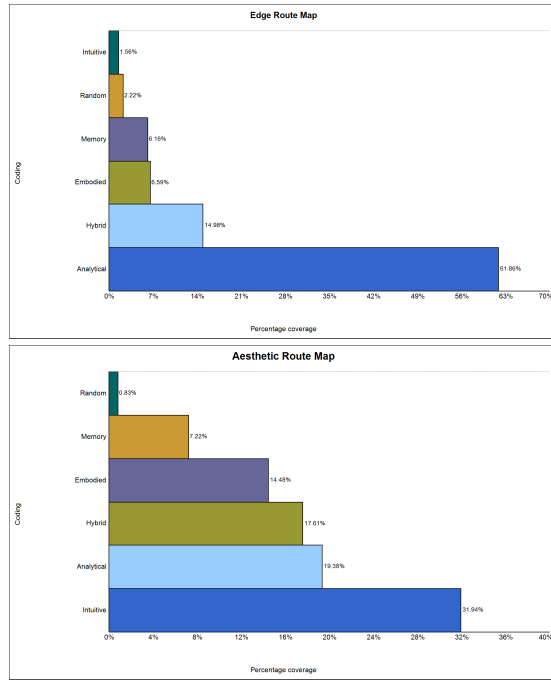
were relevant for participants in the edge and the network route maps but were not as relevant (i.e. did not appear in the most frequent words) for the other five route maps in Fig. 1. The word ‘map’ was dominant in the grid, satellite and 3D satellite versions whilst ‘colour’ features and was of significance only in the aesthetic route map. Also, the words ‘road, street, buildings and/ or paths’ etc. featured more significantly across the grid, satellite, 3D satellite and aesthetic route maps in comparison to the edge and network route maps.

## VII. ANALYTIC APPROACHES TO FINDING OPTIMAL PATHWAYS

There were several analytic methods reported in participant’s optimal route rationales. Particularly, participants reported that using the numbers provided the means in the ‘edge’ and ‘network’ versions to calculate optimal pathways. For example, participants in the edge route map reported, “I used the paths with the smallest numbers to calculate the optimal route,” as well as, “I calculated the distance between each letter and totalled them to determine which letters would allow me to have the shortest distance from A to Z.” Similarly, participants in the network route map report determining the optimal route by calculating the “Lowest path of numerical value” and, “I have used the number along each route to determine the fastest possible route to get from A to Z.”

These analytic approaches were also extended to the ‘scribble’ route map design. For example, in this visualization, participants reported looking for the shortest route available while simultaneously avoiding the scribbly lines: participants reported, “I looked at which pathways did not have scribbles on them,” and, “I avoided the more intense squiggly lines but

TABLE I  
RESPONSES TO Q1. WHAT STRATEGIES HAVE YOU APPLIED TO ENABLE  
YOU TO DETERMINE THE OPTIMAL ROUTE BETWEEN A TO Z?



still tried to choose the quickest route.” This tactic was also utilized in response to the route map visualization that focused on the ‘blur’ visual variable, “I chose the route whose lines I felt were the least blurry,” and “Shortest route and trying to avoid blurred lines was much as possible.”

#### VIII. INTUITIVE APPROACHES TO FINDING OPTIMAL PATHWAYS

Moreover, participants started to note the impact of the visual variables on their path choices across the multiple route map designs. As we have mentioned, lines which were less distinct; that is, were fuzzy, less-saturated, or had visual confusion (scribble) laid over the top tended to be avoided: “The dotted paths I associated with gravel roads and worn out roads/ paths, which I deemed as less optimal than those paths coloured in.” This was reflected once again in the noise route map, with participants reporting, “I followed the darkest and least fuzzy looking paths which again were what stood out to me first,” and “I chose the routes with the darkest, solid blacks.” However, interestingly enough, the noise route map design seemed to encourage both analytical and intuitive means to choosing the optimal route. Words such as ‘shortest’, ‘least’, ‘distance’ and ‘less’ featured in the most frequent words used to describe this route map. Moreover, participants were sensing the ‘optimal’ path through feelings that the noisy lines were less certain, less sturdy, less stable and less safe: “In my opinion, a line that was more solid represented one that was safer to travel through”, “Grainy looking lines were unsafe pathways and so I tried to choose the least grainy looking

lines”, “To me, the lines were alike to a representation of a bridge. If I were to cross a bridge, would I be willing to cross a bridge with a few missing planks if that meant I could get to the other side faster?”, and “Lines that were not whole, were not ‘definite’ lines. Seems like it’s telling me not to take routes that have blurred lines”. Moreover, in the noise route map design, it was clear that participants were feeling ‘out’ the optimal path: “ ‘Optimal’ still meant the shortest route to begin with, however I began to rely more on line shading for some graphics as most optimal due to greater shading”, “The ‘optimal’ route is one where the paths I go through are the darkest black, without any spots. I thought that if I go through those paths, I would be going on the ‘sturdier’ paths”. They even started to try to make sense of the noise: “I thought that the different intensities of black indicated the difference in path: sealed, gravel and foot-worn only”, and “the white speckles seemed to be some kind of distraction or congestion”. There was also a strong sense of ‘felt’ meaning and understanding towards finding the optimal path; a felt knowledge that aided them in the choice making: “In this case, optimal referred to the most favourable route. Compared to the previous sets of graphics where I leaned more to the most practical routes to take, I chose the cleanest possible paths (scribble route map) to take because those lines made me feel less stressed out”. Colours also had an effect on the reasoning offered by participants regarding their choice of optimal pathways. In the tone route map design, one participant reflected, “I didn’t like the colours. Kept feeling like they were dangerous pathways, but they aren’t, so I stuck to the route I knew” and another participant noted, “the route changes according to my emotion states and ‘gut feeling’”. Participants were trying to work out a feeling or a sense of the different tones: different moods, traffic levels, darker meant longer, lighter meant shorter etcetera. They were instinctively trying to sense out the optimal pathways. In the hue route map designs, participants reported, “Brighter colours represented paths which were more pleasing, deeming them more optimal” and “the most optimal routes were the ones that made me feel least uncomfortable. Some of the graphics forced me to take routes that had extremely different contrast in colours and I had to select the route that felt less bother-some”. In the aesthetic route map, one participant even highlighted: “The route with brighter colour, because bright colours just make me feel good”. Participants’ rationales reflect the emergence of affective processes which are showing not simply as tacked onto reasoning but as integral to it. Similar to study 1, there was also a strong sense of embodiment in many of the visual variable route map designs and participants adopted a strategy of imagining themselves in the navigation problem space in order to fully understand it. For example, in the noise route map, one participant imagined that the paths were walking routes that he/she could take to go to home, the shops, classes etc.: “I tried to imagine that I was walking along a network of roads and tried to think about which ones were most conducive to walking faster (ie longer paths with fewer bends”. In the blur route map, one participant noted: “I imagined the

diagrams as bird eye view maps and thought of A and Z as destinations, I then used this concept to imagine which way I would walk if I was in a hurry to get from A to B". However, qualitative data indicates that participants did not always apply much interpretation into the noise route map visualizations; indicating they simply applied 'felt' meaning and understanding towards the problem; an intuition that aided them in choosing the optimal path.

As mentioned, the experimenter-defined optimal solution was the shortest pathway and was based on a Google Map prediction for each city. This optimal pathway was arrived at by the 148 participants observing the fifteen different routemap designs for most of the cities tested (seven of the ten). On average, the optimal path was followed most accurately in the Scribble route map design (76 participants), the Edge route map design (76 participants), the network route map design (73 participants), the blur route map design (67 participants) and the noise route map design (67 participants). It was followed least frequently by the 3D satellite route map design (55 participants) and the satellite route map design (62 participants). Overall, Milton Keynes, Melbourne and Glasgow were the three cities where the experimenter-defined optimal path was not chosen by the majority. These cities were three examples from the five planned cities used in the study and when compared to the other five more organically structured cities, their neat street grids (i.e. with less directional noise) seem to afford for the participant more alternatives to the experimenter-defined optimal pathway. Overall, the grid route map design was reported to be the most preferred to work out the optimal path on as well as found to be the easiest. As participants' reports indicate that this ease and preference is likely to be a result of familiarity with the route map design: "I think because I am used to using maps on my phone?", "It was a picture that I was used to seeing and made me choose the most realistic route that I would take if I had to get to destination Z", and "Because it was in a format I am familiar with and I was easily able to distinguish the best route."

## IX. CONCLUSION

Aesthetics has the potential to provide a new dimension to the design's ability to engage its viewers, to support exploration, to encourage prolonged inspection, and to facilitate discovery of unexpected data characteristics and relationships [11]. The challenge is how we might design aesthetically to nurture an 'insight' (i.e. a way to promote a deeper understanding, both cognitively and affectively) in the problems/environments we experience. This research has explored how we might harness this in interface design where navigation choices need to be made; how we afford more 'felt meaning' in the design to influence the decisions being made. Ultimately, we found that, when performing a focused choice making task, participants will focus on the shortest route as the optimal route; however, they are sensitive to the visual variables used in the route maps of the task, as reflected in the rich qualitative data obtained through their written rationale for path selection. The qualitative data suggests some influence

(i.e. participants were sensing that the noisy lines were less certain, less sturdy, less stable and less safe etc.) but also illustrates the idiosyncratic nature of this influence, as indeed one might expect. As [12] in his book 'How to Lie with Maps' points out, colour preferences vary with culture, lifecycle and other demographics characteristics, whilst also clearly notes that shape, texture and hue are effective in showing qualitative differences in maps. In this study, we were interested in how a subjective appreciation of a visual variable (and their differences) can feed into and impact on one's interpretation and understanding of what choice to make. In many ways, as [13] describes, we are drawing parallels with his notion of a transformation, which is as much about influencing as it is about being influenced by the aesthetic. It is as much about what people feel is the optimal path to take as it is about what people think the optimal path is. Future work aims to explore the influence of the aesthetic on memory, how logical, consistent patterns of visual variables can describe intensity variations in interface designs to impact people's feelings of security especially whilst they are online. Particularly, how these visual variables can be designed to improve cyber situational awareness of users, how they can convey network navigation and be informative to protect users against potential areas and experiences of uncertainty.

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