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Department of Computer Science
City, University of London

Exploration of New Approaches to Expressing Cycling Experience

PhD Thesis
Submitted: 21. 04. 2023

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2. Supervisor: Dr. Alex Taylor

Abstract

About this Report

The purpose of this report is to demonstrate my Ph.D. capabilities.

This report summarises the direction and justification for my research. It contains an extensive literature review and a comprehensive rationale of the proposed methodology. It describes the three projects that I conducted during the research period of my studies and their implications for the proposed future work.

I would like to thank my supervisors, internal and external advisors, as well as giCentre colleagues for their unwavering support and invaluable advice. I would also like to thank City, University of London from whom I received a Ph.D. scholarship.

ABSTRACT

The overall question that occupies my work is the ways of using data visualisation, and complementing methods, in accessing the untold London cycling stories that fall in the gaps between the bars on a chart as well as striving to complement existing active travel methodologies and examine assumptions that accompany them.

Munzner [219] describes the role of data visualization as helping "...when there is a need to augment human capabilities.". Human memory is fallible and selective [21], while quantitative data alone is reductionist. This work aims to help scaffold the fallible and augment the missing. It does that by examining combinations of methodologies for eliciting and capturing cycling experiences that are more encompassing and aim to tease out overlooked aspects of active travel.

Data consists of datum (points) and, in my work, visualization is a prism for conducting, relating, focusing, and amplifying information they contain. I used maps to capture points of contact between the cyclist and their environment and interviews to capture refractions that are the result of that interaction. I did this by conducting three observational studies, the first two being linked paper studies. The first study was an open-ended study exploring the interaction of cyclists with maps, sketching, and expression. The study was conducted in person and the recruitment was conducted by convenience sampling. The second study built on the first and absorbed the vocabulary that was extracted using thematic analysis of the interviews. The study used base maps, augmentation, tokenisation sketching, and interviews.

The third study was an in-depth, targeted inspection of minority female cycling. Gender, racial and socioeconomic inequalities in active travel are well documented [176][206]. Recent macro-studies [124] [125] of gender and active travel show the widespread inequality and highlight the existing disparity in the cycling uptake by women and ethnic minorities in countries with a low cycling modal share, like London.

Hence, the study was contrived to illuminate mobility and the role of visualization in uncovering hidden powers and unseen realities of female ethnic minority cyclists. By focusing on the specific sub-group, Muslim and BAME women cyclists, it aims to get away from dominant voices and representations and reach the invisible. I used a mixed-method approach that combined ethnographic elements like participant observation with sensor technology tracking, and interactive visualization affording data-led but holistic and multilayered insights.

Methods used in this work were effective in eliciting reflection and insights that are not captured by more traditional means. Hence, the contribution of this work is in the methods I am presenting, the analysis of different forms of visual cues for communication of the cycling experience and insights into the experience itself.

This empirical work presents a new framing for considering the way cyclists use their environment and what this environment needs to offer. The last project is also giving a voice to the growing and vibrant cycling undercurrent of ethnic minority women in active travel as well as engaging the citizens-action groups that are sup-

porting mobility (r)evolution.

ACKNOWLEDGMENT

They say that the pursuit of a PhD is one of the loneliest directions to take in life. In some aspects, that is true but I have been fortunate for this to be tempered by the supportive and nourishing environment of giCentre and by having the most dedicated supervisor anyone can wish for. So, my first and foremost thanks go to my wonderful, patient, insightful, mindful, and inspiring supervisor Prof Jo Wood and to my lovely colleagues in giCentre. I would also like to thank my second supervisor, Dr Alex Taylor for his input, reflections and for always providing an alternate view of the world and research.
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A special thanks go to all the wonderful people who volunteered their time and generously shared their views and pieces of their lives with me. They bravely tackled the tasks and were open to all the ideas I presented to them. A huge thanks go to the wonderful Women Cycling Group and their fabulous CEO. I have learned a lot from them, and not all of it regarding cycling. It is a privilege to be part of such a disingenuous group. Lastly, thank you to my little family. My fantastic daughters Fay and Aine-Daisy and my husband Frank.

GLOSSARY

BAME Black, Asian and minority ethnic demographic. 182, 228

Blue-collar work An umbrella term for menial jobs. Term comes from the most common color for worker overalls- blue. The expression originated in USA.. 199

Hard to reach Groups and strata of society that has less engagement with mainstream agencies and services. . 180

Open Street Maps Open-source geographical database maintained by volunteers . 56

QGIS Qualitative geographic information systems (qual-GIS) incorporates nonquantitative data into GIS, integrates qualitative data collection and analysis with quantitative spatial analysis facilitated by GIS, adopts epistemologies typically associated with qualitative research, or a combination of these. 46

White-collar work An umbrella term for administrative posts, or any job that is done in the office. The term comes from the fact that white shirts are so commonly worn by people in this type of work that it has become an unofficial uniform. The expression originated in the USA.. 199

ACRONYMS

AT Active Travel. 180, 185

GDPR General Data Protection Legislation. 185

GIS Geographic Information System. 211

HCI Human Computer Interaction. 115

HTR hard to reach. 180, 181

IPA Interpretative Phenomenological Analysis. 119

LTN Low Traffic Neighbourhood. 126, 129, 136, 303, 325

OS Open Source. 187

OSM Open Source Map. 103, 187, 190, 227

VGI Volunteer graphical information. 103

WCG Women Cycling Group. 182, 183, 198, 199, 201

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CHAPTER 1

INTRODUCTION

"*What gets counted, counts*"[270]

We live in a world that is becoming dominated by data; in which data that is gathered becomes the foundation for the development of new ideas, means of understanding the world around us, and validation of our attitudes and actions. Haraway calls this omni-ability a 'God Trick' [135] as we often have unquestioning faith in data and blind trust in the knowledge built upon it. One of the most prominent buzzwords is 'big data' as when it comes to data, the bigger it is, the better. With size, data gains momentum and authority. I was one of the data disciples, and have followed and listened to its recommendations as well as worked on its insights and data models. In this quest, data visualization was my ally, as it helped convey the complexities and translate insights obscured by volume. However, when you look at something up close the cracks reveal themselves and working with cycling data I began to see that often what I needed to further the understanding, 'bigger-the-better' data sets were not able to provide. Big data was homogeneous and dominated the conversations. 'God trick' has become a self-fulfilling prophecy with insights thus gathered becoming truths that needed to be repeated and reinforced. I needed something to break the mould and fact-check the information big data was presenting. I wanted to explore how to expose the rest of cycling, the uncounted bit, to shed light on its hidden facets. For that, I turned to the immersive power of maps and interviews. My work started with a general exploration of how cyclists relate to maps and sketches expressively. This led me to vocabulary development and tokenisation, facilitating narration and situating cycling within broader life experiences. Ultimately, I undertook a thorough and intentional analysis of a specific subgroup, exploring how the interactive mapping of personal diaries contributes to conveying the nuances of individuals' experiences. The subgroup I chose was female minority cyclists as they were underrepresented in my other work and the wider literature.


Boston to London 215 M.
Hull to Rotterdam 240 Miles
THE WASH
LONDON
Thames Mouth
DOVER
STRAIT OF
Pas de Calais
Boulogne
Hastings
Margate
Ramsgate
Deal
Dover
Rye
Winchester
Salisbury
Reading
Guildford
Chelmsford
Ipswich
Colchester
Harwich
Cambridge
Oxford
Worcester
Gloucester
Coventry
Leicester
Northampton
Banbury
Woodstock
Aylesbury
Watford
Hertford
Bishops Stortford
Epping
Romford
Brentwood
Maldon
Blackwater
Witham
Braintree
Dunmow
Saffron Walden
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Bury St Edmunds
Sudbury
Thetford
Diss
Norwich
Yarmouth
Lowestoft
Beccles
Bungay
Harleston
Aldeburgh
Orford
Woodbridge
Framlingham
Stowmarket
Needham Market
Hadleigh
Dedham
Manningtree
Harwich
The Naze
Walton on Sea
Foreland
Goodwin Sands
Sandwich
Canterbury
Ashford
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Hailsham
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Battle
Eastbourne

ics [86] and work conventions [168] to disposition to expand on established practices and adopt new behaviours [106]. The above changes, and the complexity of factors contributing to them, mean that research into the practices surrounding cycling, and the place of individuals in the active travel landscape, is crucial if we are to keep and build on the COVID-19 cycling increase momentum. As COVID-19 created conditions that were removed from what is considered 'normal' lived experience, cycling research shouldn't only focus on the COVID-19 period. Instead, we need to identify methods that will allow us to uncover consistent trends and indicators of cycling experiences that can be adapted and applied beyond this specific time frame. Before the onset of the pandemic, governing bodies have started to officially recognize the value of active travel and take measures to limit the use of fossil fuel-powered vehicles, especially car dependency for short journeys. In London, schemes such as the Congestion Charge and plans for investment in cycling infrastructure [109, 108] have mirrored that attitude. The investment is in line with findings across the literature regarding the main factors affecting the probability of cycling uptake: good infrastructure and safety [250, 241, 53, 192, 108, 71, 157]. However, according to TfL's report [110], despite these publicized infrastructure investments, in the time prior to the COVID pandemic, there was no significant increase in the number of new cyclists. The report finds that the overall number of miles travelled by bicycle increased, but this was mainly due to existing cyclists doing longer journeys. Furthermore, work by Aldred et al. [10] has found that improving infrastructure had no impact on the demographic makeup of the cycling population, which was dominated by young males. A comparison of cycling census data from 2001 and 2011 with geographically matched infrastructure further supports this. It shows that women are one of the groups whose cycling does not significantly increase in response to the increase in available infrastructure. These findings are echoed by Lam's examination of advocacy and policy-making regarding cycling in the London borough of Hackney[177] and Steinbach's [289] study of the correlation between London's cyclists' ethnicity, class, gender, and propensity to cycle. It seems that despite greater cycling diversity and gender balance in countries with good cycling infrastructure [124], the improvement in infrastructure provision is not as effective in diversifying when the change is incremental, as it is in London, and here other interventions are needed to complement the development.

1.1.1 Active Travel

Lam [177] takes the example of one London borough and challenges the decision-making process as well as the effectiveness of the new cycling infrastructure positioning. She asserts that cycling advocacy does not reflect the borough's diversity and hence does not answer the needs of the full breadth of its population. Lam posits that to be diverse, we need to contextualize quantitative information by complementing its findings using qualitative methods. This thinking is echoed by Krizek [171], who strongly argues that to ascertain the intrinsic value of cycling, we need to look beyond functional characteristics and identify the unique, hidden landscape of the cycling experience to distinguish it from the data that can be collected by

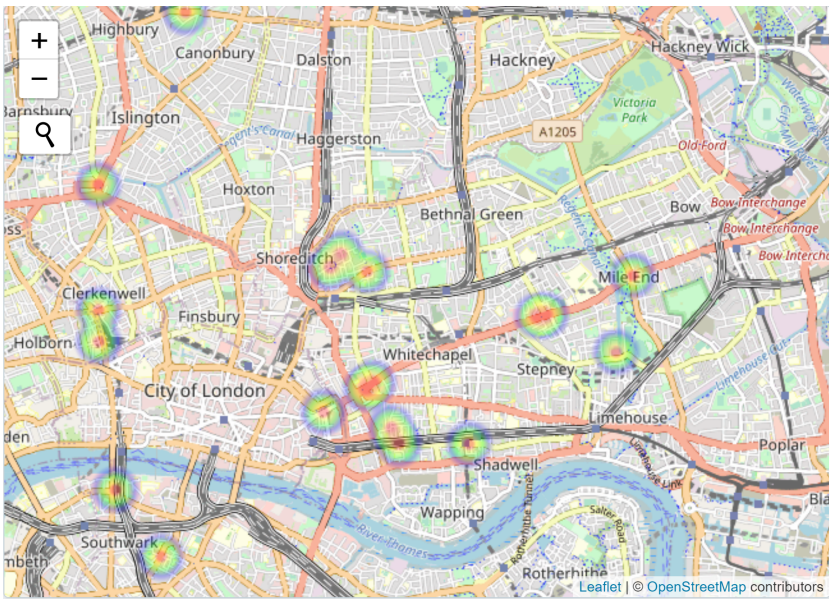


Figure 1.1.2: This is a map of citizen-reported collisions that shows collision density as a heat map.[31]

counting. The experiential data, which can be referred to as invisible data due to its elusiveness and difficulty in collection, requires attention.

The impact - and importance - of invisible data has been made evident through the work of Aldred [7, 9], who, by means of a one-day diary method, collected instances of unreported near-miss incidents across the UK. Her work generated considerable interest and was welcomed by cyclists and cycling stakeholders. The fast integration of her findings into the cycling research lore, and the deserved prominence, goes further to show that there is a ready audience for new ways of gathering information regarding cycling.

Aldred's initial method, as cited in [9], involved quantitatively analyzing incidents and their locations. However, building on this, the subsequent qualitative analysis [7] took an experience-focused approach, offering deeper insights into the effects and outcomes of near-misses. This approach also highlighted the significance of participants' perspectives in understanding these incidents.

Gamble et al. [114] go further, in that they combine written with an image diary and thus widen the methodological landscape. They seek to challenge the traditional modes of data collection and the role of cyclists' experience in city planning. Gamble adopts principles of situated knowledge [135] and merges them with statistical methods to reveal human perceptions of what is traditionally expressed as functional outcomes - cycle journeys. In their approach, Gamble et al. introduce images as a prop that supports and elaborates cyclists' narrative. Their work revealed interesting results, but the method of data collection required skilled and dedicated participants, in this case, a group of cycling activists. This choice in the sampling

further propounds the issues that Lam has raised in her work [177], in that it omits the less represented socio-economic, gender, and racial groups.

While recognizing difficulties in recruiting a diverse sample, I wish to reflect that situated knowledge closely relates to the intersection of feminist theories and data [173, 167, 139], which not only embraces the idea that knowledge is context-dependent, but in fact advocates for inclusivity and social awareness.

1.1.2 Visualisation and Cycling

Cycling and visualization have an established relationship, from simple applications that are part of fitness devices [223] to visual analysis of movement patterns [26]. Maps and cycling have an enduring connection, as we can see in this example by Mason & Payne from 1888, which was around the time that we consider the 'modern' bicycle was developed. The map seems to be developed by assigning the main roads on an existing map for the use of cyclists. Computerization and the increased ability to capture data with a greater scope for both visualization and interaction with cycling communities have resulted in the development of cycling-related visualization and projects such as citizen-science-based visualization of cycling incidents [31] or sophisticated animations of cycling journeys containing information about frequency, directionality, and seasonality of the location of cycling hire [325]. While in some of these examples, visualization is used as an ongoing analytical tool [325], in many cases, visualization is positioned at the end of the data journey. Yet, we know from anecdotal experience that what each individual does when faced with a map is to find their own house and identify their own landscape. This human tendency and its potential to inform us about individuals and how they relate to the geographies they exist in has been overlooked, but my work is putting it center-stage.

In her work on visual analysis and design, Munzner [219] reflects that data visualization is most effective when we include 'humans in the loop'. This works in two ways; humans need visualization to make sense of phenomena that are hard to grasp, and the role of visualization is to improve human understanding and perception. The Gamble et al. method relies on a driven and proficient participant. I wish to build on the great work they did and surrogate the actual journeys with visual and geospatial representations in order to facilitate insight and reflection in an accessible way.

Reflecting on the statistics regarding the uptake of cycling, there seems to be a discrepancy between study outcomes, investment, and the lived experience of cycling. I believe this is due to a combination of factors. Traditional ways of collecting data keep producing the same results which appear incomplete. This might be due to survey-specific phenomena, such as conformity bias [216, 218], where survey participants provide answers that conform to the group or popular view. The absence of a holistic understanding of the friction cyclists experience with infrastructure is another possible factor. Building on the previous work in order to enable better expression by users and capture this friction, I aim to explore the role visualization plays as a means of eliciting and capturing cyclists' relationship with their environ-

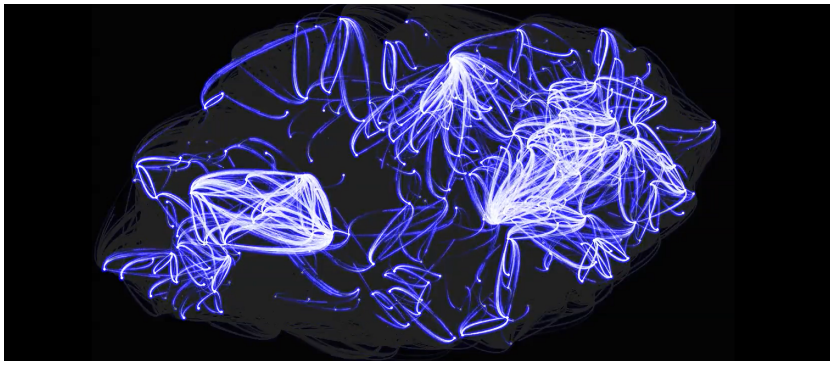


Figure 1.1.3: Still from the animated visualization depicting London cycle-hire journeys over a period of one year. This still has been taken halfway through the animation at the point where distinct patterns are emerging.

ment.

1.1.3 Physical and Human Geographies

"Geography is the study of places and the relationships between people and their environments. Geographers explore both the physical properties of Earth's surface and the human societies spread across it."[284]

As can be deduced from the above definition, geography, in one form or another, is central to the practice of cycling and its study. Physical geographies are often discussed [10, 8, 248, 279, 310] and represented [30, 84, 188, 57]. There is no lack of urban geography work that is centred on cycling in relation to health [315], uptake of cycling, and active travel in relation to cycling-friendly geographies [127]. Additionally, there's an exploration into the correlation between cycling, capital, and sustainability [287], to name a few.

Our mobility shapes our environment, as seen when we compare the population distribution and density of USA and European cities [54]. European cities tend to be denser, with Paris having 56,000 people per square mile compared to New York's 27,000. The reason behind this is that European cities were built prior to industrialization and the onset of public and private transport, so a lot of urban design was determined by the 'walkability' factor, while American transport enabled people to build residences further from city centres. Hence, we have seen a paradigm shift in London's urban travel brought about by the combination of environmental and health awareness, coupled with the changes brought on by the COVID crisis. This is likely to have an effect on the development of the urban landscape, and it is of great importance that we are equipped to gain insights and understanding of the dynamics involved.

In geography, there is a difference between space, which is measurable, and place, which is "elaborated by cultural meanings people invest in or attach to a specific site or locale" [153][14]. Where does this leave the people who cycle, and their connection to and experience of (sometimes very fleeting) spaces they travel over

and places they travel through? Hence, I posit that my work sits in the realm of human geography as its core is in human behaviour and the human relation to the urban physical environment. Traveling by bicycle transects, dissects, brushes, and skims recognized spaces and places. Cycling can be local, but in that case, we need to define the word local in terms of an individual and not spatially. Often, it is not. It passes through municipalities, districts, and neighbourhoods. It sometimes follows the shortest path, sometimes the least hilly, and occasionally it stays on the designated path. Thus, in a sprawling urban environment, such as London, people who cycle, and their experiences are difficult to capture and measure, and what we often get is fractured and incomplete. Maps can be used as a surrogate for real journeys that transcend and allow examination with fewer spatial boundaries. However, maps encode and have their own expression and representation of the world they reproduce. I aim to explore the possibilities and constraints this puts on the individuals who interact with them.

1.1.4 Research Question

While much has been done to understand external drivers regarding cycling, barriers to cycling, and the interaction of cyclists with the infrastructure, there is usually a separation between a quantitative approach that relies on numbers and a qualitative one that relies on memory. Lack of understanding of what a person who cycles senses of their environment, and the factors which create their experience on the abstract level, is reflected in town and infrastructure planning, and results in a situation where people who cycle are out of the loop when it comes to the formation of their future potential experience. I hypothesized that maps can help us bridge this divide, capture the invisible data, and create a research landscape that will host the individual and enable them to express themselves. An excellent example of the importance of 'invisible data' is Aldred's 'near-miss' data-set which contains 1532 diary entries documenting 3994 unreported incidents. These s are supported by diary entries which give context and record the impact incidents have on the cyclists'. In her work, she strives to highlight the marginalization of cycling in transport planning and provide a knowledge base for a greater understanding of cyclists' needs. The success of her work is a great indicator of the need for such insights.

Aldred notes the power and significance of reflection that her participants underwent. I argue that the use of visual artefacts as a surrogate and the freedom to imprint/find oneself in the abstract, combined with an expression such as sketching, can facilitate reflection and expression in a way that will help participants identify significant experiences, understand motivational drivers, and overcome limitations inherent in the more 'conventional' data-sets which are more limited in scope and reach.

The main research question I am posing is:

"***To what extent do maps and visual representations of cycling physical and mental ecologies facilitate new insights and knowledge gain regarding cycling experience and cyclists' interaction with their environment?*** "

This can be further broken down into:

1. *To what extent can visual stimuli, combined with qualitative methods, contextualise and externalise the cycling experience?*
2. *How can data visualisation support contextual exploration and qualitative expression of active travel?*
3. *What is the relationship between visual stimuli and responses, and do the types of stimuli predispose certain types of response?*

To tackle these research questions I conducted three empirical studies that explored different types of stimuli. The first study is an exploratory phase of the three-part project. The second phase builds upon the findings of the first, and the third is a free-standing and in-depth exploration of a cohort subgroup.

1.1.5 Aims And Objectives

The research that I have proposed, and the components that I have carried out, **aim** to contribute towards the development of a methodology that is critically engaged with data collection and data processing as well as being mindful of the situated nature of knowledge, as outlined by Haraway [135].
The **objective** was to perform a series of empirical studies and analyze the results in order to underpin and contextualize diverse cycling data we currently hold.

The overarching task can, and needs to, be further divided into the following sub-objectives:

- *Investigate the role of visualization in exploring travel experience.*
- *Reflect on the existing methods and the nature of their contribution.*
- *Design, and run, a participant-based investigation aimed at capturing and articulating holistic experience using visualization as both stimuli and means of expression.*
- *Transcribe, analyze, collate, and report findings using qualitative methods of analysis that explore reflections of the urban individuals who cycle.*
- *Develop a framework for visual exploration as support for empirical examination studies.*
- *Establish practices and recommendations for the use of quantitative methods in the analysis of complex data that combines visual and narrative outputs.*

1.2 Thesis Scope and Contribution

The research into cycling is prolific, but the cycling experience is largely reported second-hand, in that it relies on sources such as existing literature and government surveys [111]. The government collects data by random sampling, which is volatile. The results are smoothed and averaged, which obscures granularity and hides diversity, lessening insights. Other types of reporting, often used in academia, rely on counting at predetermined points [117], or extrapolation from origin-destination records [23]. By inferring purpose and motivation from such sources, we project preconceived ideas and biases on incomplete data.

1.2.1 Thesis Scope

This research is positioned at the intersection of methodologies (see Figure 1.2.1). It unifies geography, visualization, active travel, and qualitative methodologies. The body of work presented here consists of three individual projects, conducted over the three years of my postgraduate study. Each study had two main stages. The first stage was data gathering, and in each case, it lasted in the region of three months. This included recruitment and running of the individual sessions. The second, longer stage was data analysis, which was a thematic analysis for studies one and three [41] and narrative analysis [257] for the second study. The studies are geographically constrained in that only people who cycle in London were invited. This was partly for logistical reasons, as the majority of sessions, and preliminaries for the recruitment of the third study participants were conducted in person, and partly because London, as a consequence of the diversity of its cycling provision and environments, presents unique challenges for data collection. This makes London a perfect candidate for an approach that has flexibility and openness to diverse aspects of the cycling experience.

The recruitment for the first study was by way of convenience sampling [260], as the setting was the institution where I study. For Study Two, I employed targeted, stratified sampling [260]. My aim was to have a wide range of individuals who represent diversity in cycling. For the third study, I targeted a specific subgroup, female ethnic minority cyclists.

1.2.2 Thesis Contribution

Taking into account these issues, and the aims outlined in previous chapters, this thesis aims to address said gaps and in doing so is making the following contributions.

1. The new *methodological framework* that combines existing data visualization and qualitative methods in a novel conjunction and applies them to a new type of data.

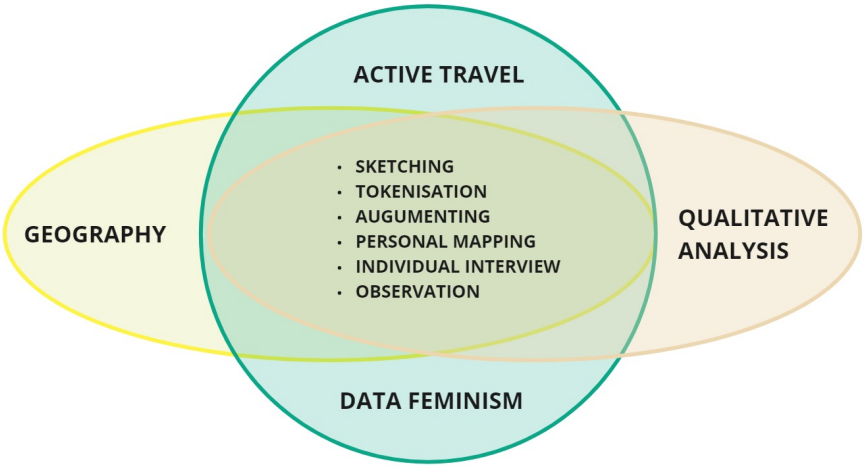


Figure 1.2.1: This is the diagram depicting how my research is situated. It sits at the intersection of data geography, active travel, data feminism, and qualitative methodologies. The inspiration for the diagram was the What Makes a Good Data Visualisation? Venn diagram by David McCandless [204]

2. *Deeper understanding* of how surrogating physical space with it's abstract representation can enable participation and knowledge sharing in active travel
3. *Insights* and knowledge gained from the three projects that I ran.
4. New *approach* to cycling data analysis as situation cycling that considers cycling within the personal narrative and not purely spatially.
5. New *ideas* as to scope and shape of minority female cyclists.
6. *Empirical examples* of recruitment and working with people who cycle in varied settings and from varied standpoints.

1.3 METHODOLOGY

This thesis presents work that uses several established methods in new combinations and on a novel dataset. All three studies have mapped geographies at their core. The first study was an open study that explored general responses to a wide range of maps and helped me develop a specialist vocabulary that was the basis for the second study. In the second study, the balance of encoding shifted from maps containing static encoding, (which was the basis for the need for different maps), to mobile encoding in the form of tangible tokens with a single cartographic representation holding it (one type of a map). In the third study, I provided a data notebook with a selection of digital maps in conjunction with other visualizations which encoded different aspects of the data.

The paper and digital studies provide a different experience from each other. A paper by Pocewicz [246] examines the efficiency and quality of responses when

using paper versus online interface for Public Participatory Information Systems (PPGIS). Their findings are that the paper elicits a greater response (more people are willing to engage with it) and far richer data. The demographics of their cohort are more skewed in the online study as the participants tended to be younger, more educated, and individuals with a higher percentage of economic migration. However, there was no difference in the spatial distribution of data. These findings need to be balanced against the difficulties of running the paper study. Ives [155] listed some obstacles in preparing, executing, and analyzing paper-based PPGIS. These relate to time, money, and expertise. Printing and preparation of the maps are time-consuming and there is a significant lag between map preparation, printing, launch, engagement, and analysis. Digitizing the process can speed it up significantly. It is also important to note that the referenced study is nine years old and that both technology and people's proficiency have advanced considerably in the intervening period. Furthermore, factors such as the study's finding that it is the younger people who are engaging with online PPGIS signal the possibility that in the near future, this might become a preferred mode of engagement. Furthermore, as a response to the recent COVID-19 crisis, agencies responsible for the type of reconnaissance that would involve PPGIS might need some developed, proven, and tested ways to reach individuals who are shielded and unable to participate in other ways.

Individual workshop For all three studies, the chosen method for qualitative data collection was individual workshops, as opposed to other popular methods, such as focus groups [41]. While focus groups have an advantage when it comes to numbers, as it is easier to have a larger number of participants in a shorter period of time, the participation is often unbalanced, as there is the possibility of a dominant personality taking over a session or of personal clashes, as was the case in the cycling Citizen Science study Spokespeople [201]. Hence, any group participation would have been unsuitable for my work as it was imperative for participants to freely explore their movement and their relationship with the environment, without questioning the validity of their output. Dealing only with one other person somewhat lessened the environmental bias, although it was impossible to entirely avoid the Hawthorne Effect (which is when participants modify their behaviour in response to being observed), especially in the third study, in which participants volunteered movements.

The value of sketching is acknowledged in the investigation of user experience [199, 46, 83], HCI [198], and visualization for its capability to externalize ideas, its immediacy and facilitating concept development [317, 272, 258].

Geographical maps such as Google Maps, or maps that can be found on the internet are general. They strive to represent an environment which is accessible by everyone, hence their aim is for their content to be recognised and consumed by many users. Such maps give us a wide view of the urban landscape, by their very nature and definition, they are devoid of the individual experience of that environment. Sketching onto the maps has provided a conduit for participants to explore, express, and imprint themselves on this canvas and overlay their individual reality onto accepted generalised representations, or to create new ones from scratch.

Corporal artifacts, including tokens, enhance participatory engagement in community-based projects [19], with additional support from insights into visual creation mechanisms [152]. They serve as connectors between abstract concepts and recipients [35]. Tokens, informed by the specialized vocabulary developed during the initial project, were employed as prompts and mediators between the broad geographies depicted on the map and specific human experiences.

The spoken and visual outputs of all three studies have been analyzed using qualitative thematic (studies one and three) and narrative analysis (Study Two). Study One was audio recorded and transcribed. The transcriptions were compared to visual outputs and coded. The second study was run after the onset of the COVID crisis and the sessions were recorded using the cloud-based video conferencing platform Zoom. The audio was transcribed and combined with physical outputs (maps with tokens and sketching) for narrative analysis. The third study was conducted in person but the interaction with the data notebook and the audio were recorded using a screen capture and audio capture. The outputs were analyzed directly from the recordings as the audio was closely related to actions and this aspect would have been lost in transcription. The limitation of the process, and where it deviates from standard practice, is that all the coding has been done by the primary researcher, so there is no comparison with an alternative interpretation. Thus it is important to acknowledge the domination of one interpretive perspective.

While running the studies, doing analysis, and reporting my work, I have striven to adhere to the principles of **Data Feminism** as defined by D'Ignazio and Klein [91]. These are:

- *Examine Power* - Examine the current practices, reporting, and representation in cycling and active travel.
- *Challenge Power* - Present a body of work that proposes a new structure for examining active travel and cycling as well as revealing novel dimensions for the study of active travel.
- *Elevate Emotion and Embodiment* - Use approaches and processes that will preserve the connection between action and emotion such as in-person interviews and analysis. Recognize my own biases and influences.
- *Rethink Binaries and Hierarchies* - Make a conscious effort to be open and inclusive in recruitment and interpretation of the results. Ensure participation of overlooked minorities.
- *Embrace Pluralism* - Be mindful, aware, and respectful of people's differences and use my work to recognise and embrace them.
- *Consider Context* - Practice transparency as to the provenance of the ideas and situations surrounding recruiting and interaction with participants.
- *Make Labour Visible* - Recognise the efforts and commitment of participants as well as my own work.

1.4 STRUCTURE

My work has a narrative arc structure 1.4.1, in that it flows from the general, the first exploratory open study, over probing and developing in the second study, toward specific and targeted, with the exploration of the particular subgroup in the third study. The reporting of my work follows the same pattern in that after setting the context and reflecting on the existing interaction between cycling and visualization, I present the studies chronologically, in the order they were run, and finish the report with the discussion.

1. *Introduction* The introduction contains the summary of my work, the research question that I am addressing, as well as aims and objectives. It also gives the context with the explanation of the problem, outlines the report structure and methods used.

2. *Literature Review* The literature review looks at the interplay of cycling and visualization, as well as examples of cycling data mapping.

3. *Finding a Way - Open Augmentation and Sketching Study* (Project One) Outlines the set-up and execution of the first project. It discusses recruitment, set-up, and reports on the running of the study. It discusses the analysis and reports on the results.

4. *Agency and reflection in cycling - "Taking my life in my hands"*(Project Two) Outlines the set-up and execution of the second project. It discusses recruitment, set-up, and reports on the running of the study. It discusses the analysis and reports on the results.

5. *Care or Self-Care? -*
   Interactive Personalised Visualisation of Logged Journeys (Project Three) Outlines the set-up and execution of the third project. It discusses recruitment, set-up, and reports on the running of the study. It discusses the analysis and reports on the results.

6. *Discussion and Conclusion* - Discusses the findings, contribution of the work and its implications.

The report contains many images of the outputs participants have produced. To increase the readability and interoperability of the report, the captions will be prefaced by the participant number and a study number in the format [Px - Study x], where *x* is the relevant participant/ study number.

1.4.1 DIVERSITY IN ACTION BUT NOT IN NAME

cyclist *noun* - a person who rides a bike. No synonyms. [Source: Oxford Dictionary [88]]

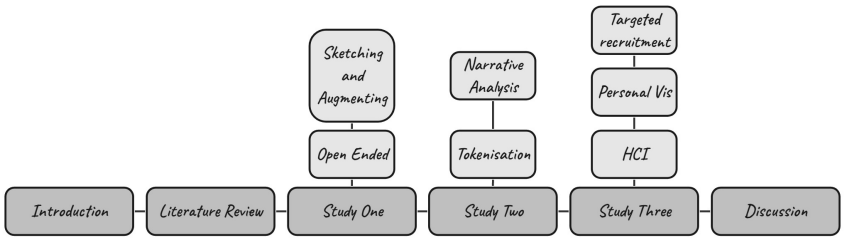


Figure 1.4.1: Project structure and how it relates to the thesis.

This section discusses the validity of the word `cyclist` and its possible alternatives.

The recent Australian study [80] has found that people find word `cyclist` *dehumanising* , *alienating* and that it leads to aggression towards people who are perceived as cyclists. Academic studies can sometimes seem remote from everyday life and these findings might be thought of as products as a very specific study that does not generalise or apply beyond its original setting. Hence, the word `cyclists` is still widely used in academia [174, 335] and colloquially.

The research on language that is used in media reports, the impact it has on people's perception of cycling [123, 194] and the people's behavioural responsibility [252, 194] has uncovered that reports which personalise events (eg. use `person driving has` instead of `the car has`) can cause a 30% shift in reader's opinions. Despite such findings, the language we use when talking about cycling has changed little and even cycling advocates use dominant discourse structures without realising it [47].

I am not an exception, and very early in my work, I was confronted with difficulties when using the word `cyclist` and when defining the participants as such. At the outset of the recruitment for the first study, two out of five people that contacted me asked if they are suitable for the study as they `cycle` but are not `cyclists`. The trend continued and participant often made a caveat "I am not a `cyclist`" when talking about their activities.

Wanting to find and alternative, I searched both the reputable (Oxford Dictionary, Cambridge Dictionary, Collins Dictionary) and the range of internet resources, to no avail. English language does not provide a simile, synonym or alternative of any kind for a word describing a person operating a bike. The vocabulary problem is not confined to the United Kingdom. The *Dutch* have two words to describe people who cycle themselves: *fietser* day-to-day cyclists in ordinary clothes and *Wielrennen* Lycra-clad fast cyclist. Further language refinement can be seen in that the Dutch have recently adapted another phrase *train-cyclists* so people that use bicycles as a part of combined commute [161].

While English speaking world has not fully embraced cycling diversity in discourse, phrases like `active travel` and *people who cycle* are starting to be used

more frequently. In her work on language and active travel, Cristina Ciamotto describes some examples of people-centric writing [18] where the word `cyclists` has been replaced with `citizens` or `people who cycle`.

Like verbal expression, visualisation has its own syntax [28], structures [304], grammar[322] and lexicons[219]. The cycling examples mentioned in the introduction explore and communicate insights about cycling within established verbal and visual vocabularies. The visual and spoken form an eco-system of representation where cycling is observed in units of *trips* [24] and classified by purpose and gender [34, 274].

One method for humanising research is the use of personas, which is limited in cycling studies and is mainly discussed in the abstract. A good example of the holistic combination of approaches is a Methods Toolkit [55]. It is a collection of methods for use by practitioners, researchers and groups exploring cycling that provides a collection of methodologies and templates for their implementation.

The importance of individual experience is addressed by the toolkit for creating personas where personal habits and priorities are recognised. However, here also, the onus is on the single journey and in this case, it is divorced from the realities of geographies Fig: 1.4.2.

My work explores visual expression and how it supports the expression of experiences that are deeply rooted both in spatial geographies, as they are in individual life-journeys. By combining visual and personal I aim to not only expand the **visual cycling vocabulary** but to provide a methodology, and a platform, for holistic expression of people's relationship with cycling, their environment and the diversity of their lived travels.

Re-imagining the active travel **spoken vocabulary** is not the aim of this work. But perceptions of and the associations the word *cyclist* evokes have been observed during the interactions with the participants. While it was not entirely possible to avoid it in conversation and correspondence with the participants, any use was done with the awareness of the meaning and the implications the word carries.

Erica

•Lives in Queens, works in finance in Manhattan

•Age 32



Relevant Characteristics & Behaviors:

•Is a senior vice president at work and must look professional and respected
•Will not wear a helmet
•Prioritizes her daughter and success at work over everything else

Key Goals for a Journey:

•Wants to get to work safely and efficiently and arrive looking nice
•Likes spending time with her daughter whenever possible

Frustrations with Existing Mobility:

•Stress of driving in traffic and possibility of train delays gets exhausting
•Unreliable bus routes make her call a cab for her daughter to get her to school rather than take the bus with her

Perception of biking as a practice:

•Unsafe, stressful, difficult
•Only for athletic people or daredevils
•She would be viewed as irresponsible if she let her daughter ride a bike, because it's dangerous and she might get hurt

What makes her happy?

•Spending time with her daughter
•Relaxing, not having to worry
•Being able to make a plan and not be interrupted by something unexpected

Figure 1.4.2: The personas are created in an idealised way and in relation to a single journey.

CHAPTER 2

RELATED WORK

This section of the report reflects on the historical, significant, and recent work in active travel research, as well as the role visualization has played in analyzing, modelling, and revealing trends.
I reflect on the efforts made in the direction of capturing less discrete aspects of urban and human experience and how visualization intersects with, and supports, those efforts.
I look at data sourcing and the role of participants.
The diversity of literature considered reflects the comprehensive and complex approach that incorporates ideas of active travel, the role of visualization, data humanism, and situated learning.
It is situated at the intersection of visualization, empirical, qualitative, quantitative, data science, humanism, and urban research.
In the following chapters, I provide a brief overview of the relevant work.

2.1 ACTIVE TRAVEL RESEARCH

Active travel and cycling have been subjects of research literature for several decades, but the recent rise in climate emergency awareness, and the general heightened consciousness of the importance of environmental issues, has underscored the importance of active travel, highlighting its role as the sustainable transportation solution. This, in turn, has led to a rise in the number of projects examining different aspects of cycling and active travel in general [251].

The topics of these works vary and have explored many facets of human-powered transportation and its role. Two of the main questions under investigation are the motivation to cycle and barriers to cycling. Studies by Zander and Horton [334, 147] examine different age groups and their willingness to adopt cycling as a mode of transport and recreational activity, while Oja, Hartog, and Tainio [233, 75] question the impact of pollution on health and the benefits of cycling [294].

A substantial and relevant body of work that focuses on cycling and active travel has been conducted by Prof Rachel Aldred, the founder of the Active Travel Academy affiliated with Westminster University. Her research touches on many dimensions of engagement with, results of, and views on cycling. This ranges from how cycling is represented in the media [194], and the effect safety clothing has on safety outcomes [12], to the impact of cycling infrastructure on population mobility [8].

Some of the more recent research in the field looks at how we form our travel identities [202] and how one's travel histories influence one's decisions today. Our mobile biographies create what Mbabazi calls "travel scripts", a recipe based on which our commuting decisions are formed. The script is a powerful construct, and Mbabazi explores what it takes to change it. She identifies that whether we are willing to change the script depends on the amount of "hassle", or as we call it "friction". Thus, we can say that the formula for change would be: less friction equals a greater possibility of change.

There are a great number of studies that focus on infrastructure and the effects it has on cycling communities [10, 265, 149, 241, 45]. Infrastructure presence/absence and type are easily quantifiable measures of friction. However, I argue that friction goes beyond the mere existence of paths and that we need methods to capture other forms of friction to integrate this awareness into urban planning.

Caimotto takes a look at the multiple dimensions of cycling, and in her recent book [47], examines rhetoric surrounding active travel that stresses the importance of the subconscious narratives reporters use. How events are reported impacts and shape our thinking. Her work complements work by Goddard [123] and Aldred [194], which looks at the portrayal of cyclists in the media and how that contributes to popular perceptions of cycling, cycling safety, and views on the cycling community. Caimotto goes further and states that we need to take control of the language and recommends a complete rethinking of the way we communicate regarding the issues of active travel. She concludes that with more forethought in the way we report events, we can enact positive change. As visualization is a language of its own, we can extend this thinking to the visual representations we create. In this work, I am examining information participants reveal in reaction to visual representations and examining the range of responses these elicit. In simpler terms, I wish to observe visual conversations and explore ways in which we can be more fluent and how we can make them richer.

2.2 CYCLE-SCAPES - VISUAL ANALYSIS OF ACTIVE-TRAVEL

From extensive exploration of the literature on active travel and the role visualization plays in it, it could be said that the intersection of active travel research and visualization can be divided into three sub-groups. Firstly, an exploration based on a journey and its destination; secondly, an exploration based on the infrastructure, and thirdly, event visualization.

2.2.1 The Journey and its Destination

The emergence of public bicycle hire schemes, such as London Santander Cycles, has proved beneficial for furthering the understanding of cycling behaviour as it provides researchers with previously unavailable information, especially on a city-wide scale. The potential and properties of visual investigation of origin-destination (OD) data have been critically examined by Adrienko et al. [17] and Wood [329]. This example of Adrienko's work focuses on directionality and the flow of movement (see Figure 2.2.1) for which they use radial maps at the origin/destination to indicate migration prevalence and curved lines to connect the outset with the finish of a journey. On the other hand, Wood (see Figure 2.2.2) has a different approach by rendering a spatial treemap which gives us an instant overview of the activity across the whole dataset. Lastly, the example of Zhou's flow-wheel (see Figure 2.2.3) addresses local fluctuations within two temporal periods and aims to reduce visual clutter to enable comparison of complex local dynamics.

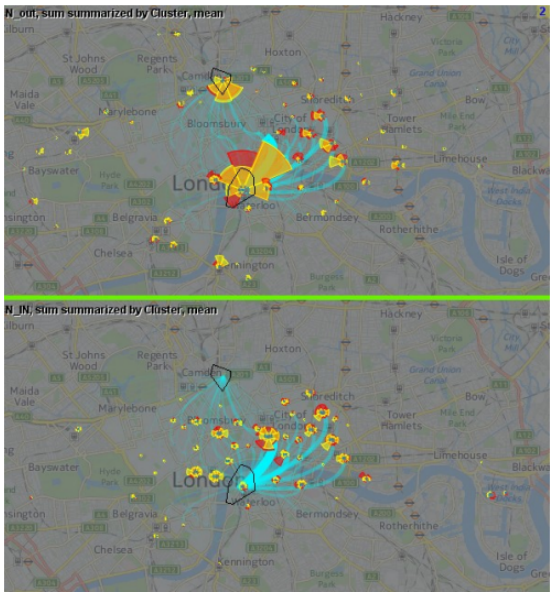


Figure 2.2.1: An illustration of OD data which includes a depiction of movement load using a radial diagram, as well as an illustration of geographical connectivity using lines [17].

We can see that OD has enabled a new level of analysis. Two examples are Wood and Beecham's **examination of commuting behaviours** [25] and the investigation of gender balance in the user population[23]. Those analyses attempt to look at the trends and tie them to discernible aspects of the phenomena. However, any examination of OD data requires a certain amount of speculation on the part of the analyst, as the specifics of the journeys, such as the choice of the route, are missed. Furthermore, when combining OD with other attributes to extract meaning, we can only say that these factors are present in the examined behaviours, but we cannot with certainty ascertain their importance above other factors.

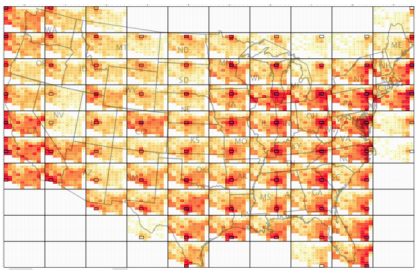


Figure 2.2.2: An OD data as a spatial treemap. [329].

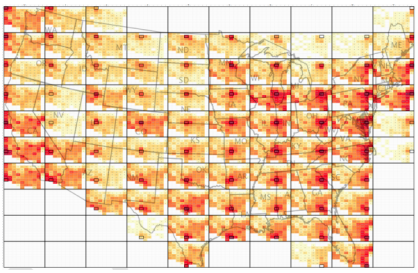


Figure 2.2.3: Summary of OD data in the form of flow-wheels which aim to reduce visual clutter [338].

Many projects rely heavily on strong collaboration with the cycling community and recruit local cycling enthusiasts to contribute by collecting data during months-long projects. Such projects suffer from the same issues as other large crowd-sourced undertakings, in that they are [115, 303] lengthy and hence difficult to repeat, and difficult to maintain, as it is challenging to sustain participants' interest and enthusiasm.

One advantage OD data has is that it transgresses municipal and geographical boundaries, inherent in data that is collected by government officials or organizations [232]. A clue as to the vulnerability of organizational data sources can be inferred from the great frequency with which researchers use crowd-sourced data. Prof. David McArthur, a senior lecturer at Urban Big Data Centre, in his recent interview with the Active Travel Academy [232], reflects on the difficulties in collating the data from different sources and at different granularity.

Crowdsourced data circumvents such restrictions and applications. Sources like Strava activity tracker, have been proven to be valuable data providers. Strava passively records its users' movements and provides information not only on the origin and destination but also the route. Not surprisingly, crowd-sourced data has become a commodity and Strava sells theirs to organizations, and individuals at a cost that is often beyond the single project's budget. Urban Big Data Centre has access to Strava data and has used it for many projects. One of these is visual exploration [203] and identification of the cyclists' deviation from the shortest path, which is performed to lay ground for investigating user choice. As we can see in figure 2.2.6, the algorithmic predictions, which model the optimal path based on distance and available cycling infrastructure, do not successfully mimic users' behaviour and seem simplified. This implies that quantitative paradigms such as shortest distance and presence of infrastructure lack subtlety and richness which help in forming human experience.

This **dichotomy between predicted and actual behaviour** has also been recognized by walking activists, as well as planners at TfL. London Living Streets has recently launched a London Footways Project. The project is in part a reaction to findings of Strategic Walking Analysis [107] which has shown that only 5% of possible walking trips are realized, and in part a labour of love for the Living Streets members who walked the streets and translated their familiarity into a visual expression aimed at communicating walkability. As explained by one of the Footways creators Emma

Griffin, in the Walking@Tea: maps and apps webinar, the project aimed to try and capture the elements, the joy and value of walking, that are inherently not present in traditional maps and datasets. Its creators are aware of the impracticability of its creation methodology and the need to find a more workable way of discovering and recording layers and nuances that influence, and colour, active travel.

2.2.2 Visualisation Exploration of Infrastructure

Another attempt at visual analysis and expression of active travel is mapping the infrastructure according to a pre-agreed classification. A work by Mineta Transport Institute [226] **classifies cycling experience** according to the level of stress cyclists experience and relates this to user groups. The Traffic Level of Stress (TLS) uses 21 qualitative markers such as road width, level of traffic, speed limit, and available lighting, to name but a few. TLS is the basis for some practical and interactive visualizations, such as Montgomery County Bicycle Stress Map[**?**] and Bike Ottawa Interactive Maps [30]. Both works are based on LTS and are meant to be used both by city planners, where they enable an **analysis of accessible cycling network** distribution and by the public as a **navigational and planning tool**.
Montgomery County Bicycle Stress Map 2.2.5 is a single interactive map, backed up by video examples of stress environments. Besides stress, it provides information regarding other impediments to cycling, such as hilliness and the presence of schools which are traffic hubs at peak times. The map lets its users explore how far they can travel from a certain origin using paths at the chosen stress level.Bike Ottawa Interactive Maps is very similar in its original premise, except that it provides a collection of visualizations with separate functions, instead of combining them in one place. For example; isochrones that show possible travel distances, route planners based on LTS, and the distribution of paths per level of stress are all different visualizations. The addition to the Montgomery model is maps of winter cycling and the desire paths. Creation of such maps gives users insight and goes a long way towards providing awareness of the distribution and **accessibility of cycling provision**. The creation of such maps relies on in-depth, city-wide data that is often difficult to obtain for larger metropolitan areas, or even in some small settings which do not prioritize transport and infrastructure development. It can also prove difficult to maintain and keep up to date.

2.2.3 Event Visualisation

Incident record is especially important when examining cycling, as concerns over safety are one of the most widely mentioned barriers to cycling [240, 7, 10, 238]. Even though Aldread has shown that negative incidents which affect cyclists, in the form of **near-misses**, are under-reported, [7] collecting this data suffers from the same problems that aforementioned crowd-sourcing projects do. Canadian-based project Bikemaps [221] has utilized the local advocacy groups to create a tool for



Figure 2.2.4: Map of reported collisions. [30]

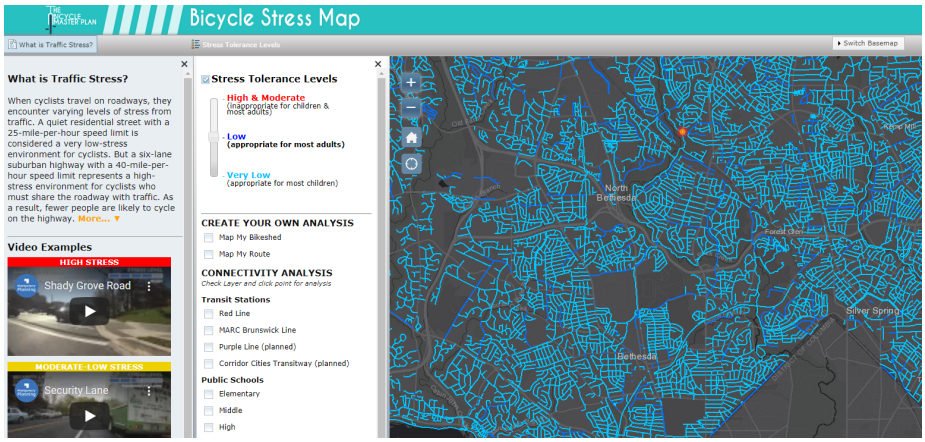


Figure 2.2.5: A neighbourhood section with roads classified according to LTSs. [?]

recording cycling hazards. Even though it has scope to be implemented on a global scale, the difficulties in recruiting volunteers have limited the results. The main output of the study is a map that presents, and exposes for analysis, citizens' reports. The reports are combined with the Strava passively collected data that enables the modelling of frequent paths. The map has great potential for personal and municipal planning. However, the maps depend on the continuous goodwill of the users as well as funding for advertising and maintenance.

On the other hand, **reported incidents data** is more available and easier to work with. Maps produced by cycling advocacy organizations, such as CycleStreets, regularly include such historic records as one of the optional layers. This facilitates better journey planning and keeps cyclists informed about high-incident areas. This approach is straightforward and accessible. However, the information relating to incidents, and other contributing factors such as the presence of road works, needs to be updated on a regular basis for it to remain relevant. While these types of visualization are useful for the general communication of incident prevalence and the identification of problem spots, the picture they create is one-dimensional and does

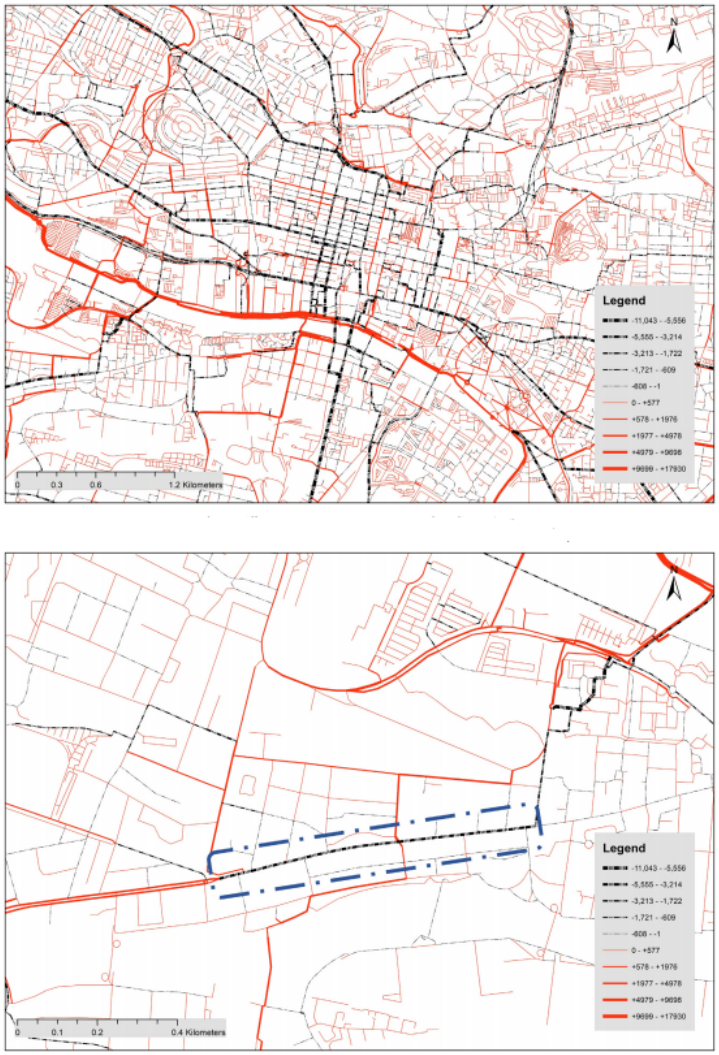


Figure 2.2.6: Visualisation of the same geographical area with the visualization of the expected routes cyclists take (lower image) and the rendering of the actual journeys (upper image) [203].

not address the positive aspects of cycling or the relationship of cyclists with their environment. The question is whether visualization has the tools to do that and how it can be employed to promote and display insights.



Figure 2.2.7: Types of obstructions causing friction that the study has identified. From left to right; cycling constraints, intersections, city-specific intersections, and landmarks. [237])

A different, innovative, technique for examining cycling, which incorporates visualization, is taken by Pajarito and Gould [237]. They crowd-source the data and target three European cities for cycling habits comparison and to demonstrate the general applicability of their methods. They used a phone app to track the participants' journeys over a one-week period. These recordings not only allowed them to extract routes but also to extrapolate cycling speed with which they identified **points of friction**. The premise for this is that when experiencing friction, cyclists will slow down. Once the points were identified, they were classified according to the level of intensity, and visualized 2.2.7. The resulting maps are then compared with Strava heat maps and with the maps of available infrastructure to ascertain if the cycling infrastructure is being used. While ease of flow monitoring is an interesting idea, and the authors have demonstrated a methodology for calculating and classifying journey friction from the raw data, collecting the data still presents quite a challenge as, despite collaboration with the local advocacy groups and intense advertising, the study has managed to recruit only fifty-seven participants overall. Furthermore, while the classification of intensity can be automated, the identification of the causes of friction still requires a 'human in the loop' who possesses local knowledge to identify the cause correctly.
From the said examples, it is becoming evident that there are factors influencing the propensity to cycle, and routing decisions, which are not captured in models solely based on infrastructure provision and the shortest path.

2.3 Multi-dimensional Cartography

2.3.1 Emotion Mapping and Capturing Experience

The idea of mapping non-corporal elements is not new. An example is Mapping the Invisible City [49] by Leicester University, which explored the **emotional connection** young people have to their environment. A recent project by Loukissas called

Map Room [187] takes this one step further by creating an immersive and interactive space with map projections as a media to invite communication and expression in an open and immersive setting. Their work explores what data means in terms of community engagement as well as allowing exploration of the spaces and their meaning in a new, active and creative way.

A technique known as **deep mapping** has emerged as a profound and insightful approach to exploring places, their connections to inhabitants, and the intricate traces left behind by both the past and present individuals [136]. A good example is Taylor's [296] examination of a single journey through London's East End while collecting personal metrics and diarising the experience. The resulting work looks at the meaning of data, the meaning of a place in its historical and present setting, and the person's journey through it. Deep mapping goes beyond the obvious in uncovering the flow and presenting a place as the culmination of its past and our perception. While searching for a connection that is conducive to understanding, deep mapping presents a picture with a very broad lens.

Guell et al. [132] focus their work on **the mismatch between what is expected and what cyclists do** by use of **mix-method approach** which combines qualitative aspects with quantitative data. The study aimed to uncover the main drivers behind the participants' decision to cycle in self-described hostile environments. The findings suggest that counter-intuitive behavior can be attributed to factors such as; local knowledge; the empowerment that active travel provides to users through increased flexibility and control over time; and participants misreporting popular rhetoric as their own experience (they do not find the environment very hostile but it is talked about as such). Overall, the report provides insight into the challenge and complexity of uncovering true motivators for active travel and highlights the subtleties of the task.

Gamble, Snizek and Nielsen [114] are using a more ethnographic approach and are immersing themselves into the cycling culture, adopting a recursive approach, where a researcher adopts multiple roles to truly get to an understanding of the phenomenon. The exploration journey is documented with **sketches and annotated photographs** that document and visually represent the experience. On the other hand, Meenar and Flamm [207] recognize the impact of emotional experience on the choice of travel mode and the role sketching has in recalling and externalizing those emotions. They use a collection of sketches that were a 'side-product' of mainly quantitative study into cycle-transit users. The primary study did not employ methods suitable for the exploration of the qualitative aspects of sketched and discursive materials. However, the mixed-method approach of Meenar and Flamm adapted well to the complexity of the task which enabled them to perform meaningful analysis and also to lay a foundation for similar efforts.

Their work is significant in the application of the method and recognizing the value of the visual expression (sketching) in **externalizing reality of hidden experience**.

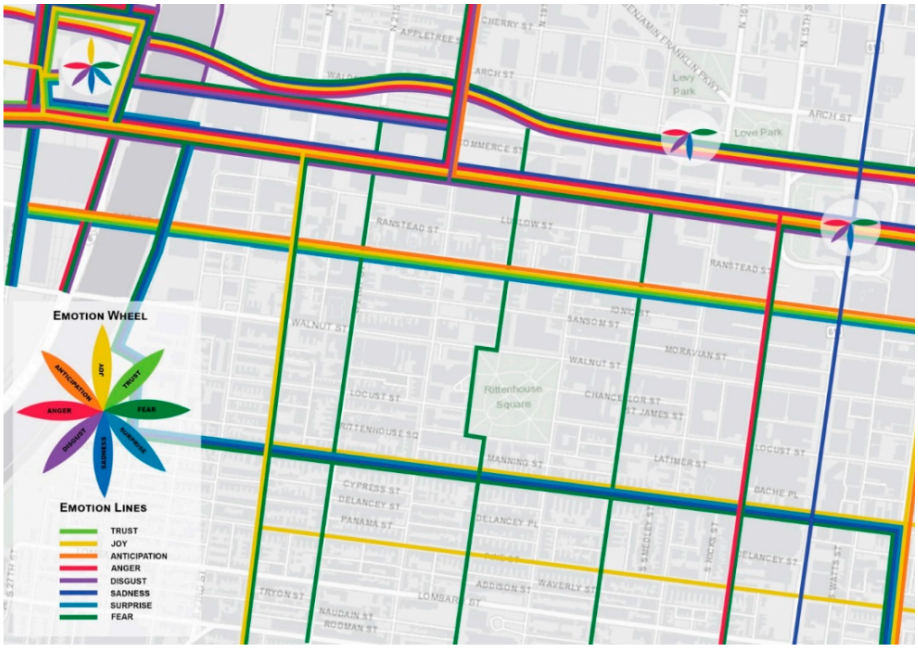


Figure 2.3.1: Emotional map of routes, where each route is coloured by a combination of dominant emotions, and landmarks are marked by an 'emotion flower' where petals are colour-coded to represent emotions. [207])

Sketching has been shown to [163] enable better representation of user experience and help participants express themselves. It is important to note that the sketching needs to be supported by verbal annotation to ensure accurate interpretation. Projects, such as the Bumpkin Island mapping project [76] combined participatory sketching with contemporary art to facilitate expression and discovery of the island. Hinrick's work firmly exposes the importance of what qualitative methods have to say [144] and pioneers collaboration between visualization and humanities [143].

2.4 Qualitative Trends in Wider Visualisation Community

As we can see, cycling, cycling experience, and the development of methods for understanding them have been the subject of a lot of inquiry. Visual analysis has proven to be an important tool in the exploration of active travel and its geospatial aspects. However, we have seen that this top-down approach, where we use visualization to explore quantitative aspects, is not without its limitations. Cyclists' behaviour often does not follow the expected patterns [203] and sometimes interventions have unexpected outcomes. This is the case with the Mini-Holland scheme that was piloted in outer London and which was aimed at increasing the uptake of

cycling. While the longitudinal tracking study [8] has reported an increase in cycling, the biggest impact of the scheme is in the amount of walking.

In recent years, the visualization community has increasingly been expressing awareness (at events such as visualization conferences IEEE VIS 2019 and 2020) that visualization needs to expand its scope and incorporate qualitative aspects, practices, and elements. A paper by Dykes and Meyer [209] proposes a new approach to rigour in visualization that adopts considerations, models, and values of humanistic, qualitative research. This has also been a topic of discussion and reflection at the recent IEEE VIS 2020, where it was suggested that in the future visualization should expand and incorporate deeper aspects of the topics and that this could be achieved by adopting the mixed-method approach.
The trend is supported by a growing number of publications addressing the rift between the depth of qualitative analysis and the reductionist nature of datafication and data visualization. Layers of Meaning(LoM) framework [179] addresses the semantic difference between visualization and humanistic research in an effort to bridge this. On the other hand, Karer et.all discuss the idea that every visualization is situated and seen through the lens of the analyst's experience.

What my projects aimed to do was to incorporate quantitative aspects in the form of project meta-data, participant statistics, representational characteristics of materials, and geospatial characteristics of their route with the semi-structured interviews, open-question surveys, and sketches. The 'Bottom-up' approach of using the visual representation of the routes proved to be a good vehicle for eliciting meaningful reflection and insight into the reality of cycling and helped to uncover causes of friction as well as mitigators and compensators that helped cyclists overcome them.

2.4.1 Personal Data Visualisation and Counter-mapping

Data visualization is an analytical tool but also a vehicle for personal reflection and exploration. The prominent work in this sphere is the published personal-diary correspondence of Giorgia Lupy and Stephanie Possavec [191]. Here, the two designers explore their everyday lives through data capture and visualisation while simultaneously playing with the design process. The design and the exploration of personal procedures and rhythms are also a topic of Perin's work [243] where he records and presents a year of activities in a way that allows the reader to see the interplay of different demands on his life and progress. These are examples of personal visualisation and designs by people with solid academic and professional foundations in data management and expression but we know from anecdotal evidence that diary-keeping is a common practice, which sometimes involves data capture and presentation. A notable example of a successful data-capture diary is the 'Tran-delay Scarf' [1] by Sarah Webber, a journalist. The scarf can be seen as an example of personal expression and expository representations usually seen in radical cartography.
Radical cartography is an approach, of which counter-mapping is a branch, to mapping that challenges the traditional themes and dominant narratives, often by fo-

cusing on underrepresented and marginal communities [267]. The terms radical cartography and counter-mapping are used interchangeably due to their similarity. However, it can be said that radical cartography focuses more on the unconventional representations of space, while counter-mapping is more concerned with challenging the power structures and countering dominant voices. One of the better-known examples of counter-mapping is "Where Commuters Run Over Black Children, Detroit 1968" [141]. A map, which is deceptive in its simplicity, rendered in the style of the seminal John Snow's Map of Cholera Outbreaks" and just as powerful in its eloquence.
In the context of mobility and cycling, radical cartography has been used to present and highlight the hazards of urban cycling. An example of this is the recently published interactive "Map of Dangerous Junctions" [142] that presents the last five years of data on emergency responses to incidents involving cyclists and pedestrians. The map integrates visualization which relates the frequency and severity of incidents overlaid on a traditional map. On the other hand, a bicycle workshop with black youth in US presents counter-mapping as an exploration from within. It is a process of development; both of cycling ability and visual literacy which ultimately enables both spatial exploration and personal expression [298].

2.4.2 Sketching Externalisation and Maps

In my work, I used **sketching** as **sketching externalization** which Walny [316] defined as "...use of writing, sketching, or other graphical expressions to create a visible interpretation of internal thought. " That is to say, the participants were not confined to one type of expression. In the first and the second studies, participants were presented with visual prompts and supplied with a range of materials that allowed them to modify and augment the prompts, or create their own, unique outputs.

As the tasks participants were given relate to their travel through geography and its cartographic representation, it is relevant to point out the distinction between mental mapping and sketch maps.**Mental mapping** is free-hand and without base maps. It is not geographically accurate and is used to illustrate the importance of things in the sketcher's view. **Sketch-maps** are geographically accurate and a way to counter-map the traditional representations of cities and environments [42]. The review of the literature shows that while both mental mapping and sketch-maps are combined with interviews, surveys, and other narrative forms of data[42, 50, 20], they tend to occupy separate spheres.
The first study, in particular, allowed the participants to give a multi-faceted account of their experience, in that it let them to choose how they wished to express themselves. The participants who used sketch maps first were then asked to render output on blank paper and vice-versa. The prompt for both types of engagement was to ensure consistency in the analysis and establish how much these two ways of expression differ or correlate in their outputs.
Both sketch maps and mental maps have been used in the examination of the relationships people have with their cities and Brennan [42] used sketching to identify hot spots and high-traffic areas that are of importance to the creative community.

This was done to develop a sense of how creatives interact with the city. By combining cognitive and spatial, he aims to provide insight and representation. Brenan's use of mental maps is based on the premise that using mental mapping without base layer maps accentuates features that are important to the individual [165, 20, 193]. I argue that the base layer provides a context that encourages and reinforces the connection between the geographies and the real experience.
In his seminal work [193] Lynch uses sketches and mental maps to explore how citizens 'see' their cities and has identified the five most important features that help create an impression of one's environment. These are **paths, edges, districts, nodes, and landmarks**
Bochmann [38] points out that the importance of mental mapping is in understanding human behaviours that is based on the perception of the surroundings. He sees mental maps as a **vehicle for externalizing socio-spatial dynamics** and introduces a **counter-mapping** perspective. This reactionary stance complements our thinking and is validated in my preliminary findings, although in the remit of sketch mapping, as many participants used them to point out discrepancies between represented infrastructure and its actual usability.
Catney [50] uses mental mapping as a vehicle for an exploration of social complexity in ethnically diverse neighbourhoods and to uncover how a neighbourhood is perceived and understood by its residents. Their assertion that *'One size does not fit all'* can also be applied to cycling, as while millions of people are united by choosing to cycle, their abilities, needs and comfort zones differ. In the first study I ran, the participants were given a free choice to express themselves by mental or sketch maps as I wanted to explore the role maps play in eliciting a response. Both techniques have been used in the exploration of cycling and Marquart et.al[200] utilize sketch maps to examine perceptions of the cycling infrastructure quality, while Manton [195] turns to mental mapping to gain insights into the perception of the cycling risk. Buxton's work [46] explores sketching for design development and his collaboration with the Data Experience Laboratory of the University of Calgary [130] is a comprehensive guide to sketching methods and uses. While it is aimed as a handbook for individuals and teams, the general guidelines for the sketching processes are also applicable to participatory sketching. As we can see from these examples, mental mapping is more prevalent in Qualitative GIS (QGIS) than sketch mapping, due to the assumption that it elicits more distilled responses. Both sketch maps and mental maps have been widely used to broaden the understanding of interactions and perceptions people have in regard to their environment, and have been utilized in the research of cycling, but not as widely as in other areas of city analysis. I believe that has great potential in furthering understanding of what matters to cyclists and as a vehicle for externalizing this.

CHAPTER 3

FINDING A WAY - OPEN AUGMENTATION AND SKETCHING STUDY

3.1 INTRODUCTION TO THE FIRST STUDY

The first study is exploratory as participants were presented with an an open-ended task. The study involved running 14 distinct workshops, each serving as a unique data collection session for a particular individual. In each workshop, the participant was provided with 16 different renditions of the geographical areas as well as drawing materials (more detail on the running of the sessions can be found in the subsection 3.4.1). The geographical area renditions contained regions specified by the participant as cycling locations during the preparatory correspondence. The recruitment of the participants was conducted by way of convenience sampling [41] at the home research institution. The outputs were analyzed by way of thematic analysis [41].
During the workshops, participants were asked to express what matters to them regarding cycling using the materials provided. They were not led as to which aspect to examine and express or in which order to engage with the materials. The only stipulation was to avoid writing.

The aim of the study was to:

- Study the impact materials and the process have in supporting participants' creativity and expression.
- Extract emerging themes in spoken and visual expression.
- Explore how non-experts visually interact with maps.

3.1.1 The Context for the First Study

When approaching this project, my assumption was that people who cycle experience friction, which influences their progress, experience, and the future of their movement through the environment. We can define friction as anything that slows the cyclists down, as was defined and utilized by Pajarito [237]. However, not every type of interference has a physical manifestation. Difficulties in isolating these have led me to the premise that we could employ visualization as a bottom-up stimulus for eliciting recollection and fostering expression. To understand the problem and prepare for the analysis of the information I collected, I conducted an in-depth literature review a summary of which can be found in chapter 2 of this thesis. Additionally, to widen my understanding of cycling knowledge, I started following research centres and active travel advocacy groups such as Active Travel Academy, London Cycling campaign and Living Streets. I familiarised myself with the relevant researchers and publications, attended conferences and webinars, and where appropriate, took courses.
A search of existing data sources has uncovered that there is no pre-existing data or combination thereof, that would address my research questions
- *To what extent can visual stimuli, combined with quantitative and qualitative methods, contextualize and externalize cycling experience?*
- *What is the relationship between visual stimuli and responses and do the types of stimuli predispose certain types of response?*

In order to contribute to answering these, I needed new data and an approach that would help create a paradigm for future applications. To this end, I devised an empirical study that is to be a basis for the building of the theoretical framework. The study contributed towards understanding what types of representation foster the best response, the best being the response where a participant engages with the material and produces an output. Also, whether the participants choose different representations for different aspects of their experience.
The study had a preparation stage, which consisted of the pilot and the ethics proposal, and the main part included participant study, analysis of the material, and the formulation of the theoretical framework based on the analysis outcomes and the lessons learned from the empirical aspect.
The individual workshops had several components, which will be described in this chapter.

3.2 The Pilot for the First Study

In order to maximize the knowledge gain, make the empirical part of the project as efficient as possible, and for it to be user-appropriate, I ran a pilot that enabled me to test the procedure, timings for the tasks, the efficacy of the questions, and willingness of the participants to engage.
The pilot study differed from the main in that I used a printed questionnaire sub-

section .1.1, provided sculpting material, and used pre-addressed postcards in lieu of the feedback form. The postcards were blank on both sides so that the participants could draw or write their thoughts. The participants were chosen from my neighbourhood and were recruited by word of mouth. Since the purpose of the pilot was purely to test the procedural aspects of the empirical component of the study, it was decided that six participants would be sufficient.
The location for the sessions was the participants' private residences. In order to ensure both researcher's and participant's safety, City safeguarding guidelines have been observed. The findings of the pilot were that all the participants engaged with the questionnaires and the sketching activities but only one used the postcard to provide feedback. Furthermore, the participants found some questions in the survey unclear and several redundant. All the participants engaged with the sketching to some extent, although some reassurance had to be provided due to people's lack of confidence in their visual expressive abilities. Buxton discusses this in his book [46] and argues that the reluctance to draw is a major barrier to collaboration and communication in design. I followed his advice to encourage participants to sketch freely and assured them that my interest is in the ideas and information they were conveying and not the quality of their drawings. This was expected and it was found that the level of reluctance was lower than anticipated. Also, it was established that providing 3D materials did not bring any added value to the output in the scope of the research questions. All the participants were very animated during the interviews and said that they found participation in the pilot a positive experience.
Based on these findings, the plan for the main study was modified subsection .1.1, flagged questions changed, and the survey, as well as the feedback form, moved to the online platform. Furthermore, the 3D materials were omitted from the main study.

3.3 Running The Empirical Study - Study One

This study has been approved by Computer Science and Library and Information Science Research Ethics Committee (CSREC) and complies with the City, University of London guidelines.
Following the approval, I started **the recruitment** of the participants. This was done by means of advertising over internal social networks and by leafleting and postering on the campus using pre-approved poster design. Due to operational considerations, the participants were recruited from my place of study as this added an extra layer of safeguarding and made attending sessions easier for the participants. The posters were placed on the corridor display sites, next to bicycle parking bays, attached to bicycles, and on the notice boards in the supporting staff areas. The initial aim was to recruit 30-40 participants. Qualitative studies, due to the depth of the analysis, do not require large numbers, but the quantitative analysis does [41]. The first response to the recruiting efforts was enthusiastic, but as it coincided with the academic industrial action, new responses soon stopped. The final number of recruited participants was 16, out of which 14 completed sessions. The reasoning be-

Participant Statistics			
cycled in UK	1<10	10<20	20<
	8	1	5
occupation	support staff	student	academic staff
	6	5	3
gender	female	male	non-binary
	8	5	1

Table 3.3.1: Table showing the length of UK cycling experience, occupation bracket, and gender distribution for the 14 participants.

hind finalizing the participatory stage at that juncture was that the study has reached a point of saturation [41], which is the stage when no new insights are provided by the participants. Also, the point of saturation coincided with the onset of the COVID global pandemic and in-person sessions had to be halted.

It is important to note that one of the recruiting goals was to provide a diverse sample and reach cyclists who tend to be underrepresented in the data collected by passive means, such as the Strava activity tracker. Strava users represent just a subset of the cycling body [194] despite the data being used in studies that make wider population generalizations based on the behaviours of its users. Strava advertises itself as a performance tracker, and as such, it is used by individuals who are in training or engaging in cycling as a sport. City commuters, occasional, and utility cyclists will be under-represented in such a set. Lam [177] points out that representational bias goes beyond *passively collected data* and that female cyclists on low income, as well as cyclists of color, tend not to be a part of the advocacy groups and hence, their views are not a part of visible cycling rhetoric. To refer once more to feminist geographer Joni Seager and data feminism advocates Klein/D'Ignazio [90] *"What gets counted, counts."* In order to represent everyone, we need to include everyone in the conversation. However, it is important to keep in mind that this study is a proof of concept and its main goal is to establish a framework that could be applied in a wider scope.

Since recruitment was limited to the university, the sample is inherently constrained in its diversity. This is despite every effort being made to recruit participants from all aspects of university life; students, academic, administrative, and support staff. The study promotion was designed in a way that ensured everyone who cycles felt invited and included, and adverts were placed in locations that are accessible to all.
Despite these efforts, the study only received applications from the teaching staff, administrative support, and student cohort Table 3.3.1, there were no applications from any of the support staff(utility, catering, technical support, or house cleaning). It is important to note that this is not a reflection of the gender ratio of cyclists at the university as male cyclists outnumber females, but could be a reflection of female cyclists' under-representation awareness and a greater willingness to assist. However, this can only be speculated, as the answer is beyond the remit of this study.
Furthermore, due to the international nature of the institution, more than half of the

How important is cycling as a form of self-expression?				
Extremely	**Very**	**Moderately**	**Slightly**	**Not at all**
5	2	6	1	0

Table 3.4.1: Table showing the importance of cycling to a participant's self-identity.

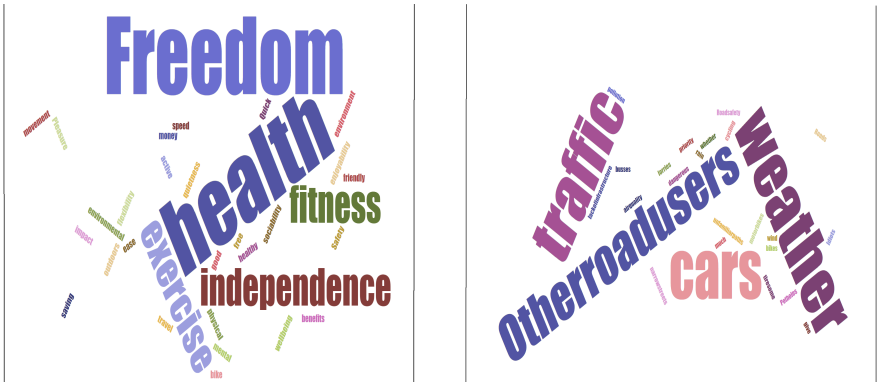
sample are cyclists who are not native to London or the United Kingdom, This will be taken into account in the analysis. One can hypothesise that the friction either reduces or changes with familiarity.

3.4 THE SURVEY

To take part in the project, participants had to be of adult age (18 or over), with no upper age limit. They were screened only on the basis of whether they cycle and this was done by self-nomination. No other criteria were applied. All the participants had to fill in a survey that collected demographic data as well as inviting them to express their attitude to cycling. The survey consisted of ten questions. Seven questions were of a quantitative nature, where five questions were posed in order to collect demographic information about the participants and two were regarding their cycling experience and experience of cycling in the UK. The last question asked them to express the personal importance of cycling and to what extent it is part of their self-expression. Nine participants have expressed that cycling is either an extremely, or very important, part of their self-expression, while none have opted for the 'not at all' Table 3.4.1. More importantly, the survey results did not differ from and **did not show new insights** into cycling, attitudes to cycling, or cycling experience as discussed in the chapter 1, chapter 2. This highlights that a fresh methodological approach is needed to uncover more nuanced and un-expressed dimensions to cycling.

To establish a baseline regarding their attitude to maps, they were asked if they use navigational tools (eleven of the participants answered yes) and if these representations relate to their perception of their environment. The opinion here was divided, with five participants expressing agreement and four stating that they do not match their perception. The wording was chosen due to the fact that these days most of the navigation is digitized, while anecdotal experience tells me that the word 'map' is mostly associated with paper.
In order to be able to assess the possible impact of the interaction with the sketching materials and base maps, I posed a couple of qualitative questions, inviting the use of free language for expressing what matters to them in relation to cycling and what makes it difficult. A preliminary assessment of the responses shows that, when it comes to cycling, participants value the freedom that it gives them and are aware of the health benefits Figure 3.4.1a. On the other hand, overwhelmingly, for them, cycling friction is caused by weather and other road users. This is mostly, but not

exclusively, general motor traffic Figure 3.4.1b. That said, weather is a local phenomenon. Looking at the survey, it is evident that the majority of our participants are new to life in the UK. Consequently, part of the adjustment is learning to function in a new climate. Furthermore, at the time I ran the study, we were experiencing an unusually dismal, and prolonged, period of rain and low temperatures. Hence it is not surprising that weather was prominent in people's minds, but it does raise the question of its overall significance. Would it be mentioned as frequently if the survey was conducted during the summer months?



(a) What is important about cycling?

(b) What makes cycling difficult?

Figure 3.4.1: Word clouds for the participant's answers regarding what is important when it comes to cycling.

3.4.1 INDIVIDUAL WORKSHOPS - STUDY ONE

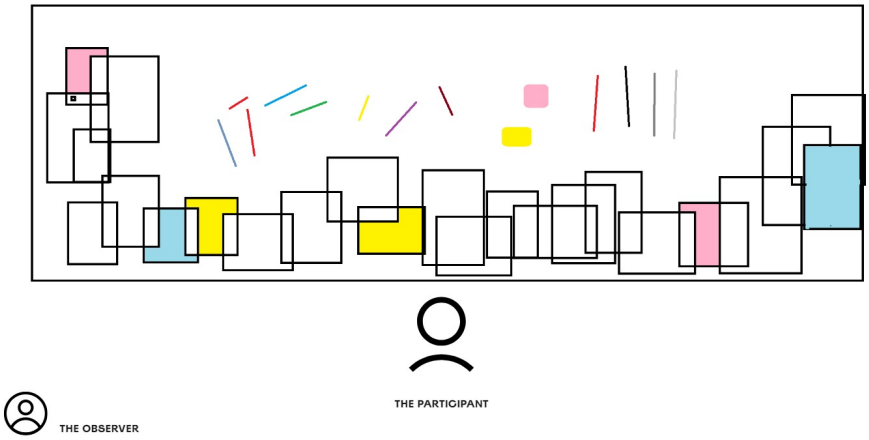


Figure 3.4.2: This is an example of the table layout. The rectangles with borders represent papers and maps, small squares and rectangles without borders represent Post-it notes and the lines represent pens. All the sessions had a near-identical layout, the difference being the size of the table, which depended on the space. The paper and one example of each type of map were within easy reach for the participants from the position in the middle of the table. All the extra chairs were removed before the session to allow participants freedom of movement. The researcher sat behind, out of the way.

The workshop sessions were individually run so that participants were not influenced by what anyone else was doing and had a chance to pace themselves based on their own needs. Each session had a two-hour allocation, as the pilot section 3.2 has shown that the mode length of time for the completion of all the tasks is an hour and twenty minutes. I added half an hour to make sure that participants could take longer if they needed to. The participants were not kept beyond the completion of the task. The sessions were run on campus and the time was at the participants' convenience.

The provided materials were:

- *White, blank paper* - I wanted to see if the participants would choose a map or paper first and also when asked to sketch, how they would express themselves.
- *Coloured, blank paper* - I wanted to see if the participants would use the colour coding provided by this material.
- *A collection of maps with different features and the amount of detail* - I wanted to see what maps participants would find valuable, and to hear why.
- *Coloured pens, coloured pencils, and highlighters* - People might have preferences as to the type of drawing material they prefer to use, so I provided a wide range in order to avoid this being a barrier to engaging with the other materials.

- *Sticky notes* - Participants might wish to add written or sketched notes. At the end of the session, they were asked to label the sketches to facilitate analysis.

3.4.2 Table Layout

The participants were given a comprehensive set of colouring and drawing materials, as listed above. As well as pens, pencils, markers, and highlighters, the Figure 3.4.2 was covered with a selection of maps interspersed with pieces of blank, white, and coloured paper. Care was taken with the layout, so that there was no section of the table that contained only maps or only blank paper, as I wanted to minimize influencing their decision regarding the choice of expression media. There was a possibility that grouping, as outlined by Gestalt principles, [214] or immediacy, would influence their choice, as participants might simply use what was closest. Care was taken to include a balanced and representative sample of maps and papers in the middle of the table, as I anticipated that the participants would position themselves in the middle of the long side as it provided the greatest overview and the best reach. Furthermore, all the chairs and furniture were moved away from the table and closer to the walls to provide unimpeded access and facilitate free movement. The participants were made aware that the chairs were available and close by if needed.

3.4.3 Maps

For each individual, I have produced 16 types of maps. Starting with pre-produced maps like Open Cycle Map and Google maps, progressing to custom maps made using QGis software. The latter gave me design and structural control. The maps varied in level of detail and features included. This ranged from very crowded Open Cycle Maps to the very basic rendering of streets devoid of features. In producing the custom maps I avoided inserting landmarks such as buildings of importance and retail/hospitality structures as they were present in the OSM and Google maps. The pre-produced maps and the features they contain are indexed in Table 3.4.3 and the maps I have created in the Table 3.4.3.

London covers a large land area and it was necessary to identify relevant sections to produce maps at a workable scale. Printing a map of the whole of London with the necessary granularity was neither practically, nor financially, viable. I needed to find a format that was easy to produce and easy to interact with for the subjects. The maps were prepared based on the information that the participants provided in the preparatory communication. The geolocations were given in answer to a question: *Where do you usually cycle?* While this was an open question in the sense that it did not prescribe a type of activity that can be performed (eg. commute, social enterprise, leisure, retail), the presumption was that there would be some overlap in the cases where the participants commute to university. While this has been proven right in the sense that all of the participants have prioritized work/study commutes over other cycling, the area in the immediate vicinity of the university elicited a min-

imal number of observations. This will impact the analysis in the way that I have generalized the type of environments participants chose to highlight, rather than focusing on a particular location and varied impressions of a specific location.

When preparing the maps, I wanted to give participants a wide choice of options. As there was no precedent, that I could find, for this type of approach, I needed to consider what I was aiming to do and what that needed to encompass. Upon some reflection, I narrowed down the basic specifications for maps to these:

- The selection of maps needed to contain both maps that are familiar and maps that are less familiar to participants. This was to establish to what extent participants preferred the prevalent maps, as well as their openness to different maps. When talking about prevalent maps, I refer to maps in the Google navigational tool and the OpenStreetMaps, as they are two leading mapping platforms in the industry [220].
- Maps that are currently aimed at the cycling community as they contain specialist features, such as cycle paths and the location of repair shops.
- I wanted people to sketch, hence a proportion of maps should be rendered in a way that could invite this. I rendered my maps with a white background, as that is reminiscent of canvas, and participants might find it easier to draw on this as the drawing would be more visible.
- I needed to have each map representation at a different scale to allow participants to explore their journeys on different levels. I decided there should be maps encompassing whole journeys as well as maps of zoomed-on sections, which would allow for a more detailed examination of neighbourhoods.

Map name	Hues	Roads	Features
Google - Basic	Muted, light hues	Yes	Yes
			
Google - Satellite	Dark hues	Limited to major	Yes
			
OSM - Cycling	Muted back, vivid cycling	Yes, distinct	Yes
			
OSM - Transport	Muted, vivid transport	Yes, less prominent than transport network	No
			
OSM- Dark Transport	Dark, vivid transport	Yes, faint, less prominent than transport network	No
			
OSM - Landscape	Pastels	Yes	Catering
			
OSM - Outdoor	Muted Pastels, roads stand out, names stand out	Major	Catering
			

Table 3.4.2: List of ready-made maps.

The additional criteria in choosing maps were the 'first search' or availability. The maps were chosen within the scope of the most immediately available search results in the browser. The search was done on the premise that people search for the maps by area and activity. Acting on these requirements, I settled on sixteen map variations. These can be classified by origin: Google maps, OpenStreetMaps and maps produced by me using QGIS and Processing software. Google and contain the features that are present in the maps that were available at the time of the search. These features have not been modified. An effort has been made to provide a wide choice to test participant preference and the relevance of feature presence. Maps were created using an open-source graphic information system called QGIS (this is different from Qualitative GIS that I have discussed in the introduction) and I built them devoid of 'higher' features such as landmarks as these are present in the already available maps. The maps vary in complexity and the map with the most features contains roads, road names, green areas, areas of water, and buildings. I wanted to see what level of detail the participants would find suitable for their ex-

pression and hence produced maps with decreasing detail the Table 3.4.3.

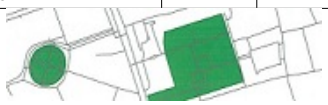
Map name	Hues	Road names	Landmarks
QGIS	White background, high saturation of hues used for features	Yes	Green areas, areas of water and houses
QGIS	White background, high saturation of hues used for features	No	Green areas, areas of water and houses
			
QGIS	White background, high saturation of hues used for features	Yes	Green areas, areas of water
QGIS	White background, high saturation of hues used for features	No	Green areas, areas of water
			
QGIS	White background, high saturation of hues used for features	Yes	Green areas
QGIS	White background, high saturation of hues used for features	No	Green areas
			
QGIS	White background and black	Yes	No
QGIS	White background and black	No	No
			
Handy	Tan background and gray rendering	No	No
			

Table 3.4.3: List of maps I made for use in the first study. The maps are canvas-like in their hues and rendering. In this table, I have included examples per number of features.

3.4.4 The Format of the Sessions

Once the participants were welcomed and the admin tasks were completed (for the in-depth workshop plan please refer to subsection .1.2) they were asked to express *what matters to them in cycling* using the equipment provided. They were informed that they could use any materials and in any order. The only constraint was not to produce prose. Upon completion of the first task, the outputs were annotated (using Post-it notes provided) in order for the analysis to be true to the subject's intention, as the sketches themselves could leave a lot to interpretation.
While taking into account that the presence of maps predisposes thinking towards

the spatial aspect of cycling, [42] all the individuals that opted for sketching onto maps as their first activity, were asked if they could produce a paper drawing on the same theme. The reasoning for this extension was that the blank paper does not impose constraints that are present when augmenting a base map, hence aspects that are not location-based can be expressed.

Furthermore, geographical maps not only spatially position the thinking, but also act as a vehicle for situating the output in the actual experience, as seeing the locations refreshes the recollection.
Once all the outputs were annotated, I conducted a **semi-structured interview** at the outset of which the participants were invited to explain their work in a process of contextual narration. The importance of combining methods can be illustrated with the work of Wartman [319]; a study that compares features identified by the use of language and with the features elicited by participatory sketching. In their study, analysis of sketching identified 74 features, while language-focused work resulted in 156. There was an overlap of only 23 features. The discrepancy in the number of features is not a surprise, as language is an easier form of expression - we communicate with it daily. However, the lack of overlap is unexpected. We hypothesize that the common features are 'bridge features' and present a link between two types of expression. The presence of discrepancy signals that neither technique is sufficient by itself for expressing the entirety of the socio-spatial relation people have with their environments. While the layout of our approach is somewhat different, and the nature of the discourse I have engaged participants in predisposes it to have more cohesion with the drawings, nevertheless Wartman's findings have possibly significant implications for this type of research.
While explaining the outputs, the participants were asked to structure the narrative in order of importance. In other words, not to start with the sketch that was rendered first but with the one that resonates the most, and that they feel is the one that is the best representation of their cycling outlook. The contextual narration was open-ended and structured only by its binding to the drawn material. The openness and freedom allowed them to elaborate, and many added anecdotal elements which increased the knowledge generated by the drawings and situated it in the personal experience. During this time participants sometimes inserted, or accentuated, existing markings, and I made light notes that documented the flow of the events. These were meant to assist later coding and analysis.

The final part of the workshop was a set of thirteen questions that were put to every participant. This structured section was necessary in order to scaffold the project as it ties in with the survey. It also means that there is consistency in themes that were discussed with the participants and ensures that the main considerations regarding the volunteers' cycling behaviours are noted. The questions served as an evaluation of the subject's satisfaction with the process and the effectiveness of the approach.
The subject's involvement ended with a follow-up survey a week after the in-person session. The survey asked for participants' reflections following the study and self-assessment of the influence participation might have had on their cycling. Out of 14

participants, 12 engaged with the feedback questionnaire. Out of 12, 6 responded to the questions asking for their reflections and follow-up thoughts. 3 participants remarked that their engagement with the study has made them reflect more about cycling and its benefits, while 3 participants said that participation has had a direct impact on their cycling. In some cases, this manifested in more experimental route choices, while in some cases participants said that they became more engaged with the act of cycling and their environment.
In the next sub-section, I will outline the plan for the analysis of the outputs and extraction of the cohesive personal narratives, as well as general conclusions.

3.5 The Analysis Methodology

The analysis of the first survey is relatively straightforward due to its small size and the fact that it mostly consists of quantitative questions. The survey is useful for contextualising the study as it informs us of the sample demographics. The qualitative questions give us a baseline, as well as a starting point for following the participant's thought development. The survey was conducted using Qualtrics survey platform, which extracts the data and presents it in an easy-to-analyse form.
The more challenging undertaking is the analysis of data collected during workshops. The sketches and maps can either be digitized and coded using a qualitative analysis tool, such as NVIVO, or the coding can be done by hand. While the software is effective, in that it is easier to store, compare and manipulate material, I have found the initial coding process can be cumbersome and slow when used for smaller samples and have combined manual coding with the use of NVivo.
Sketches lend themselves to more traditional thematic analysis [41] where themes are identified, coded, collated and examined for their prevalence and for the relationship they have to each other. Broadly the drawings can be divided into two categories; drawings that convey emotion and other abstract ideas relating to cycling, and drawings that convey the space by replicating the journey. The main emphasis of my analysis was the augmented maps and the sketches.

While sketching and mental mapping seem neglected in the qualitative reference literature [41, 278], they are well represented in the research [50, 200, 42, 38, 193] in general, as they are means of distillation and externalization of human-environment experience. Gieseking/Jen [121] attempts to address the discrepancy between application in research and theoretical texts by compiling, discussing and augmenting methods for its analysis. The investigation of the existing literature led them to 36 analytic techniques, which they found insufficient as these did not cover the needs of their own work. In order to provide a more comprehensive list, they added 21 techniques of their own, giving us a total of 57. Those techniques were categorized according to the specific combination of drawing elements, mechanics of the method, narratives of the place, and the personal connotations for the participant. The number of techniques, and the sense that the list is not definite, illustrate the sensitivity and peculiarity of working in the qualitative field and the idiosyncrasies

of working with participant-created visual output.
The classification made by Lynch [193] has identified classes of spaces that are given particular attention in drawn maps and sketch maps. These are paths, edges, districts, nodes, and landmarks. Lynch's work was a walking study but his classification is still applicable to us, as nodes can represent junctions, turnings points of interest; paths - roads, districts - land masses such as parks and long stretches of particular infrastructure, and edges - boundaries between different districts. This classification has been echoed in the work of Tversky [306] which identifies components of sketch maps as segments, paths, landmarks, elements, and actions. Tversky draws our attention to the idea that **in sketching, spatial relation is not confined to the concrete, but can represent the abstract concepts, as sketches do not represent reality but the concept of it**.

Munzner [219] has presented us with a deep and comprehensive framework for the understanding of visualization components. However, the non-expert sketching expression of experience does not map well onto that classification, as many assertions do not apply due to the constraints maps impose and the limits of material given. Hence, I have used open coding [52] to develop a classification that is based on the outputs participants produced and is rooted in my research question.

I have divided them into how participants express themselves through various aspects of map interaction and interpretation :

- **Expressivness** - are they creating texture (dots, dashes) or emphasis (scribble, wavy)? As we already have roads, are the participants merely positioning themselves on the map by marking a line, or are they communicating something more, and how? Also, how are they marking an area? Are they simply marking and using what the map provides (putting a boundary), or adding to what is there (texture)?
- **Use of Colour** - if they use colour, do they use it as a signifier (red is often used for danger or importance) or for classification (assigning different colours)?
- **Intention** - are they depicting a journey or an area? This might tell us something about how they move and how they see the territories they move through.

Overall, the analysis will be layered, in that the basic classification will be applied to the sketches and the way the participant has marked them noted. The emphasis will be on the use of the visualization channels. The second layer of meaning will be extracted from the recorded interviews describing their work.

3.6 SYMBOLS AND SEMIOTICS

In their outputs, participants both produced symbols and responded to the symbols that the map contained. The definition of a **symbol** is "something that stands

for or suggests something else by reason of relationship, association, convention, or accidental resemblance "[208]. So very broadly speaking, the symbol is a visual representation of a thing or a concept. **Semiotics**, on the other hand is "... the study of signs and sign-using behaviour" [44]. While this is not a semiotics work, the propensity of participants to use them and the abundant presence of symbols in maps, means that there is a need to define and clarify their subgroups, types, and how they will be classified for the purpose of analysis in this study.

In his work "Semiology of Graphics", Jacques Bertin [28] states that symbols are employed for communication between a single element and a reader. He also observes that symbols are a result of acquired habits and thus cannot be universal like other variables such as shape, size, or order. However, symbols can be categorized as to how they connect to what they represent [81] as they have different levels of abstraction:

- *Pictorial symbols* - a direct representation of something else which resembles it closely (smiley face).
- *Functional symbols* - representation of a function by exemplifying, using direct representation (a book represents reading).
- *Conceptual symbols* - represention of a concept. (heart represents love or joy)
- *Conventional symbols* - conventionally used and accepted for representation, but do not have to have a direct relationship with the thing they represent (cross, tick, road sign).
- *Abstract and geometric symbols* - shapes chosen by the designer to represent a feature.

A further search of symbol classifications has uncovered a certain degree of uncertainty and overlap. As an example, a smiley face is defined as a symbol, icon, and ideogram. For this study, I am defining **symbol** as something that will be used as a general reference to anything that is a pictorial representation i.e. that is not a line, area, bounding, or texture. It can depict equally a feeling, phenomenon, function, or item. For effective analysis, a higher granularity is needed, and going forward, taking into account the subject matter, they will be classified in the following way:

- **icon** will be used for direct representations of emotion. (for example a smiley face, or a heart)
- **pictorial** will be used for direct representations of an object. (for example a tree, or a traffic light)
- **road sign** - participants use road signs, and as road users, they have adopted the road sign language. It is also important to distinguish them from other symbols as the use of the road sign might indicate the higher importance of the road structure (for example, the triangle with an exclamation mark for danger).

- **arrow**- indicated direction and context. Something might be true in one direction while not applicable going in the opposite way.
- **punctuation** - punctuation has often used a shorthand (for example an exclamation or a question mark)
- **mark** - there are some symbols that are difficult to categorize but they are used widely. (for example a tick or a cross, as in crossing something out)

3.7 Text Analysis

Putting aside the availability of cohesive methodology for hand-drawn material analysis, qualitative methods such as thematic analysis [225, 323], and methodologies such as Interpretative Phenomenological Analysis (IPN), [122] have been used for the analysis of interviews and participant produced text in the area of active travel. Thematic analysis is a method for the identification of common themes and extraction of patterns and common meanings [41], while IPN is a methodology that aims to uncover the subject's relationship with lived experience. Glackin [122] uses IPN to explore the lived experience of a small group of recreational cyclists in order to uncover what motivates them, and sustains their engagement with cycling. Being interpretative, IPN seeks to uncover meaning beyond what is articulated, or what could be counted [281]. This does not mean that the thematic analysis and IPN are mutually exclusive.

Legend for colour coding of the text	
Hue	**Meaning**
Yellow	General observations regarding cycling
Light Blue	Personal observations regarding cycling.
Purple	A statement capturing the essence of the narrative.
Red	Use of an evocative or strong word.
Gray	Explanation for the use of visualization channels.

Table 3.7.1: Table showing the hues used for the text coding and their meaning.

In order to proceed with the analysis and the coding, the interviews needed to be transcribed. This is a lengthy process and an hour of the interview can take between four and ten hours to transcribe, depending on the quality of the recording and the experience of the person doing the transcription. It is recommended that the researcher does the **transcription** [41] as this gives them a chance to familiarise themselves with the data, make observations and incorporate the **coding** in the process. My project produced roughly fourteen hours of recording, which I transcribed and pre-coded Figure 3.7.1. Being a novice transcriber and due to the fact that I coded the interviews while transcribing (this required frequent consultations with the sketched outputs and my notes, on top of listening to the recordings), transferring one audio took several days. The labour that is required to do this is often over-

looked but it requires a significant effort that, in line with Data Feminism principles, [91] needs to be acknowledged. The coding was in three layers.

The first type of coding was applied directly to the text where the sections of the text were highlighted using different colors. The Table 3.7.1 is a legend showing which colour was used for which purpose.

The second type of coding is a section theme extraction. The third coding was the insertion of a number of summaries and observations directly into the transcript as a third person, a person *I* (in each script the participant is *A* and the interviewer is *B*). Capital letter I stands for interpretative, as it takes into account nuances, such as tone of voice and the intensity of the statement which cannot be captured by transcription of the words themselves.

3.7.1 Recognising Research Bias

It is also important to recognize that there is no such thing as unbiased data [91] and this applies even more to data analysis and interpretation. How we approach data, what questions we ask, and how we interpret it, relies on our knowledge, intention, and understanding of the world [52]. In qualitative research, bias is mitigated by collaboration.

If we look into a dictionary [89], we will see that the word *bias* is defined as tendency, inclination, or opinion, especially unreasonable. I would challenge that for the reasons outlined above, no research is done without a position, and our positions, though they need to be declared, are what make us invaluable. We bring our unique mixture of expertise and experience. This leads us to ask questions and find answers to them. My work reflects my position as a person who cycles, as a female person, and as a researcher who is interested in the expression of human experience, how we capture and represent it. Throughout this work, my position has been mitigated by my supervisors, their (considerate) experience, knowledge, and unique world views.

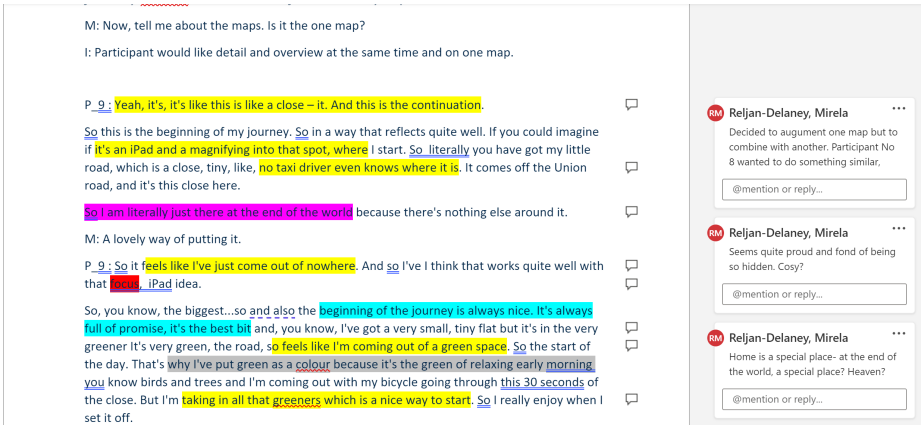


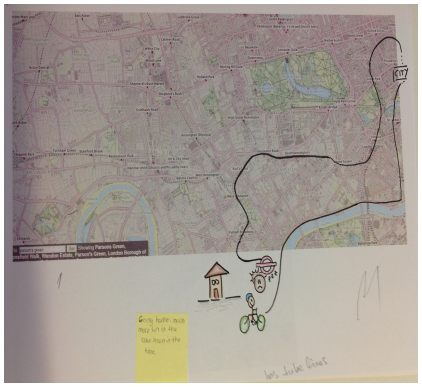
Figure 3.7.1: This is an example of a coded, transcribed interview. Colors represent broad themes and the notes provide context.

3.8 Analysis - Study One

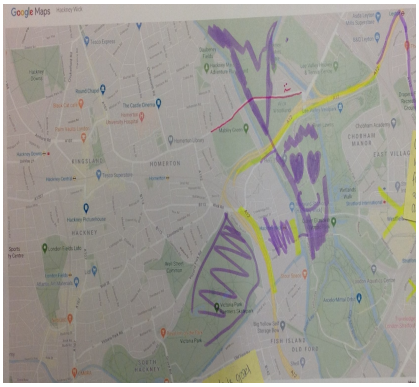
Thirteen out of fourteen participants engaged with the maps first, and created one, or several, **map-based outputs**. All the participants took time at the start of their session and studied the material before engaging with it. In some aspects, participants' approaches to the task varied greatly. While some had difficulties engaging with maps Figure 3.8.1a but were drawn to them and included them in their output, some embraced them in a way that almost seemed as if they had imprinted themselves on the landscape and playfully modified it Figure 3.8.1b. Only one participant decided not to use maps at all and opted to render only a **sketch on paper**. However, most of the participants produced several augmented maps in order to capture different facets of their cycling. The prevalent focus of the sketches was people's commute to work, with some participants including leisure and only a few including journeys for retail purposes.
The participants produced a wide range of outputs that could fall into mind maps, sketch maps, or even illustration categories. For the purpose of clarity, I will be calling the work participants produced with maps **augmented maps** and the work they produced on blank paper as **sketches**.

Participant 1

"...its like an open bus tour...every day..."
Participant One commutes to work through Central London, which they find enjoyable and challenging. They have several routes that they use to and from work that they take depending on factors such as time of day, time available, and whether they would like more exercise. They developed their visual language using maps and carried it through to the drawing, which is a **mental map** summation of the themes explored while mapping. Their visual language consisted of abstract representations. They augmented seven maps depicting routes. On all the maps, roads are distinct

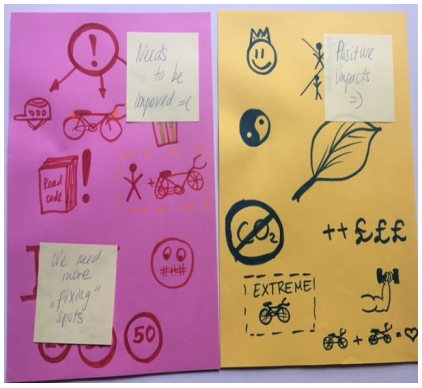


(a) Participant choosing maps but using them for sketching.

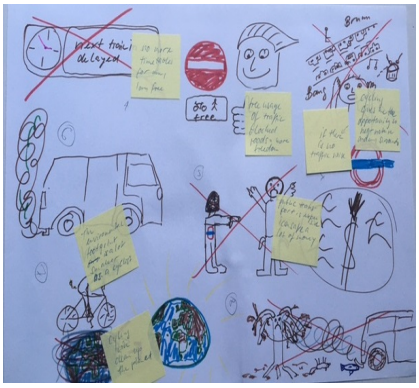


(b) Participant using map features to anthropomorphize the landscape.

Figure 3.8.1: Two examples of very different approaches to sketching mapping.



(a) Sketch where the participant uses the hue of the paper as one of the channels of communication that underlines their statement.



(b) Participant using direct cues, such as red hue and crosses overlaying mimetic representations.

Figure 3.8.2: Two representative examples of a sketch.

and they used light-coloured maps. Apart from light hue, there is no other feature that is consistent for all the maps. They used line texture to emphasize differences between sections and bounding for points, such as junctions. In 6 out of 7 maps, they used colour but the classification they assigned was not consistent across the maps. The inability to maintain the colour-feature assignment became evident during the interview. In some cases, they used the same colour to highlight two different features on the same aspect of their journey as cycling conditions changed depending on the time of day and direction Figure 3.8.3. A good example is the case of Richmond Park. The participant marked the same route in two hues, representing positive and negative. They also gave each of these aspects an individual treatment on separate maps.

In another representation of Richmond Park, the participant marked the boundary by a series of close vertical lines, reminiscent of a fence, thus separating it from the rest of the city. They named Richmond Park as their favourite cycling destination. Overall, the participant used lines and boundaries with no symbols (bar one

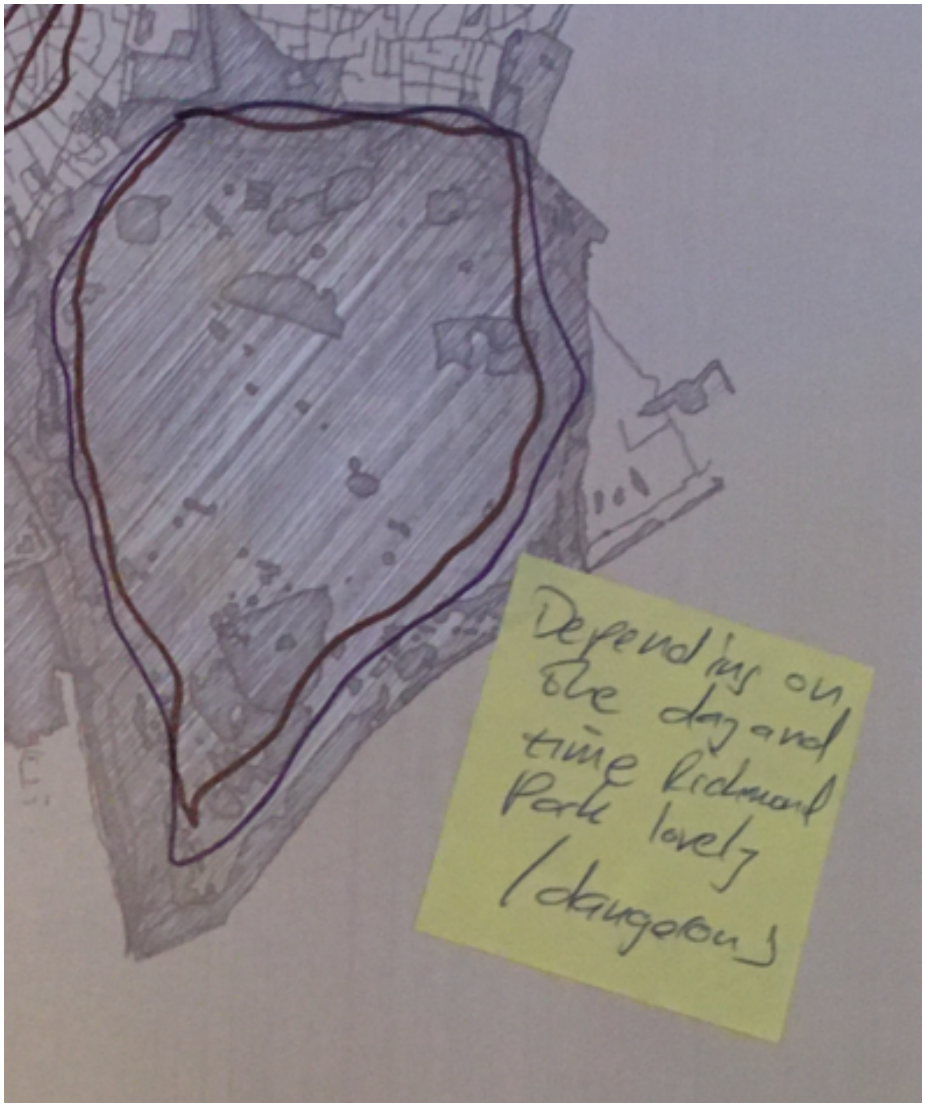


Figure 3.8.3: [P1 - Study 1] The example of Participant One representing two different experiences at the same locality by use of colour. “Richmond Park can be lovely or dangerous depending on the time of day”.

on map seven). When asked, the participant could elaborate discursively on the section but not as to what each encoding represents.

In their **sketch**, the participant was more consistent with the use of colour, as they marked and assigned different colors/textures to good infrastructure, not to a fun route, and normal route. The participant has marked four ways that they take to reach their destination. The sketch was a skeleton of and collation of different aspects the participant has discussed in maps, but it contained less information.

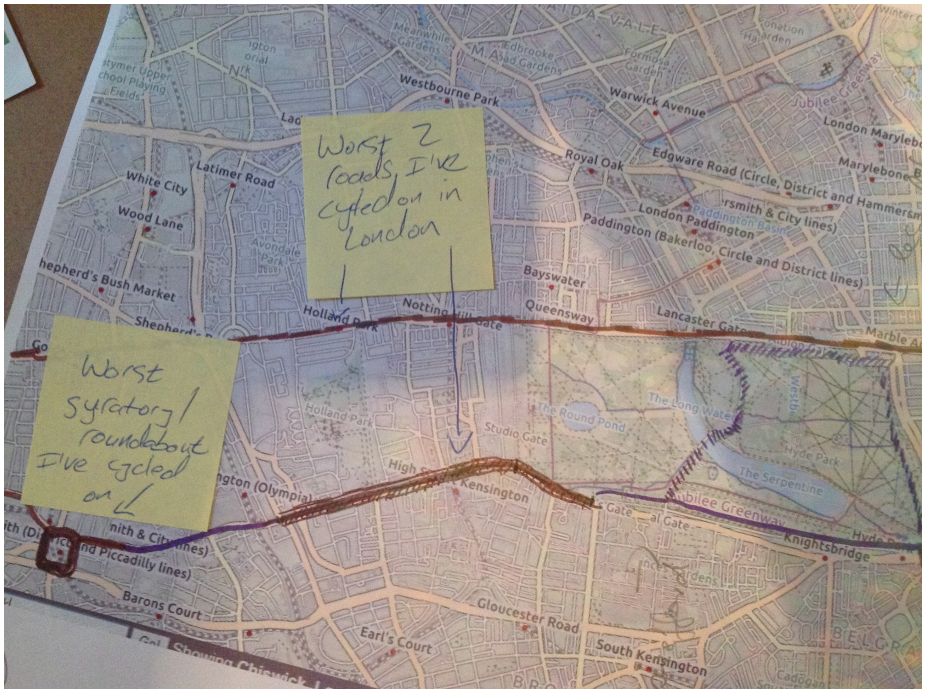


Figure 3.8.4: [P1 - Study 1] Participant One example of the subconscious behaviour in *fencing* the area of positive experience.

3.8.1 PARTICIPANT 2

" *...looking at it all I just picked out the ones that have either like the bus routes or something like that.*"
Participant two was a very prolific individual as they produced a total of nine augmented maps. They chose maps based on attractiveness, familiarity, and features they found appealing, like bus routes. The participant's visual language largely relied on **iconography** in both sketch-mapping and drawing output. They exhibited **feature latching**, in that they strongly relied on what was already contained in the maps. This is evident in two maps where the only marks they made were circling the existing features. The participant has a definite and individual voice and on top of widely using accepted iconography (trees, animals, etc) has developed their own symbols, e.g. symbols for uphill, downhill, and wind Table 3.8.1. We can also see how the participant is representing feature combinations in order to deal with locations that evoke layered and complex associations. For example, going fast downhill is both pleasurable and dangerous, while cycling around the former Olympic area is evocative, pleasurable, and connects to a specific past event. For this participant, cycling an uphill stretch was particularly unpleasant as they used **multiplied encoding** of arrow, icon, and mark Table 3.8.1.

Maps 8 and 5 are double, in that the participant has used the same type of map (same visual design but one map had street names, while the second map did not)

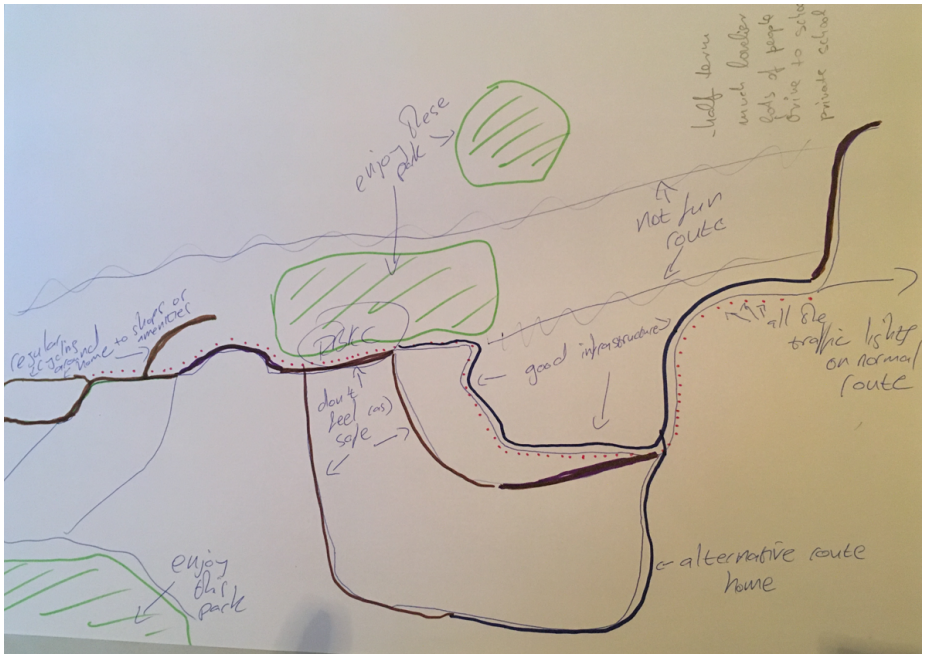


Figure 3.8.5: [P1 - Study 1]Participant One has mapped their most frequent journey and classified infrastructure. They also included parks in the sketch as the rides in the parks give them joy.

and has tried to express something along similar lines. In the case of map 8, we have some collections of streets. One map has potholes marked, and the other states that it is a 'warren of streets' Figure 3.8.1. Both augmentations have the same visual encoding and the boundary features are consistent.

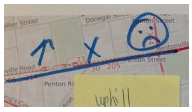
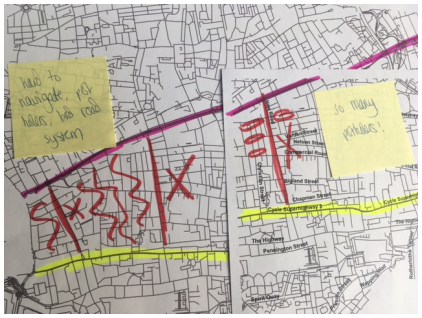
			
Downhill	Uphill	Memory	Wind

Table 3.8.1: [P2 - Study 1]Participant Two has created a range of symbols to augment the maps.

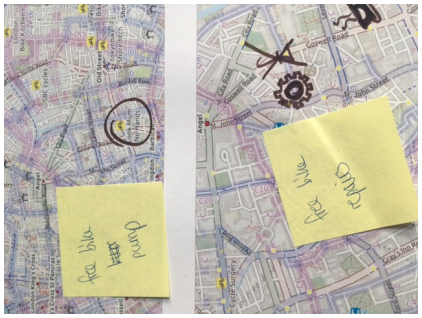
Their sketch

3.8.2 PARTICIPANT 3

"*In the UK, cycling feels like home.*"
Participant three used the margins of maps to summarise their experience by drawing cartoons. This participant is a sports person and their primary activity is en-



(a) [P2 - Study 1] Participant Two's use of more than one map in order to 'find' the issue.



(b) After latching onto a feature the participant has used a similar map to develop their expression.

Figure 3.8.6: [P2 - Study 1] Examples of Participant Two using multiple maps for exploration and development of expression



Figure 3.8.7: [P2 - Study 1] Participant Two sketch. The rendering is divided in two with one half devoted to positive associations and the other to negative. The imagery is consistent with what the participant produced while interacting with the maps. The colour choice appears random.

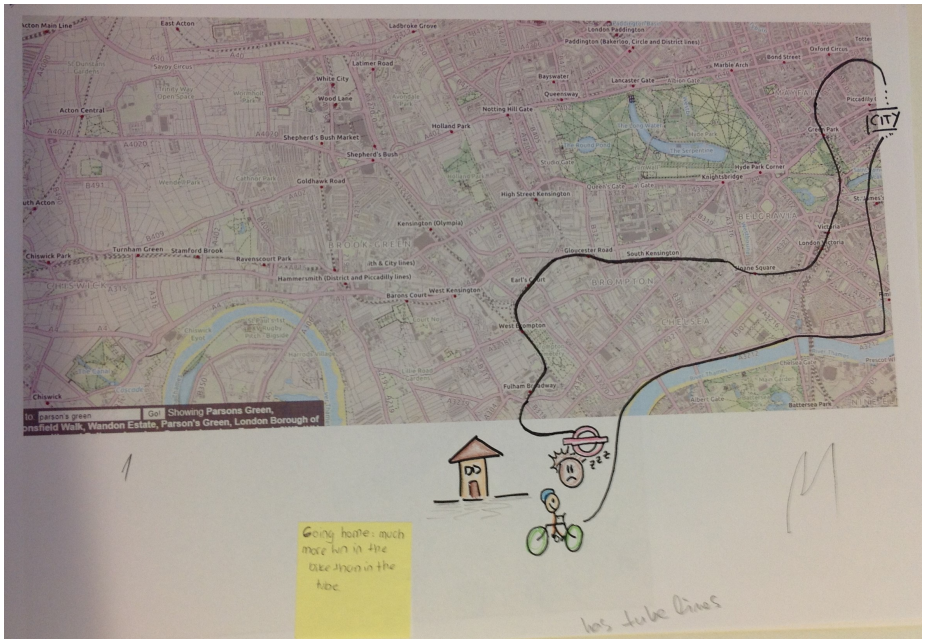


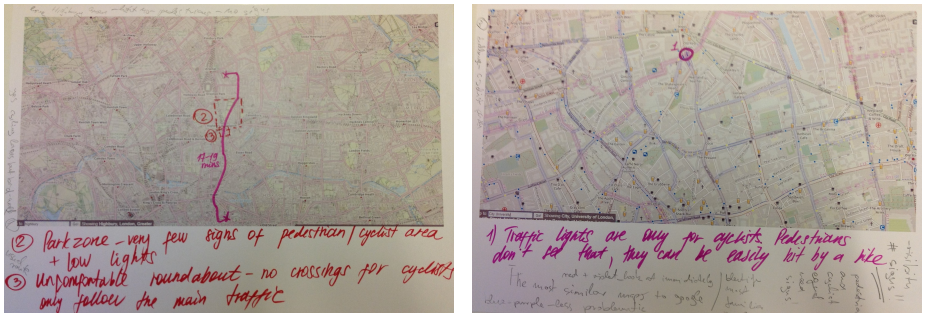
Figure 3.8.8: [P3 - Study 1] Participant Three has used the margins to create a pictogram.

durance cycling, which they do either on a stationary bike or away in rural areas. The participant is a student in their second year of UK study and has not acclimatized to the UK's colder temperature or gotten confident navigating the city. However, they were still drawn to the maps and used them both as a base and as a canvas. For this participant, cycling is a strong part of their self-identity and is important for their self-care regime when it comes to both physical and mental health.

3.8.3 PARTICIPANT 4

" *I am not terrified by traffic.*"
This participant did not follow the instructions, in that a great deal of their expression was in the form of a written narrative. However, the amount of text decreased as their work progressed. During the interview, this participant demonstrated loquaciousness that was unmatched in the study, and they revealed a fascinating level of detail that the map interaction evoked. The participant chose either Google map representations or maps that are close to it in hue and representation (OSM Cycling Map). The first feature of the cycling experience they noted was its efficiency and speed. This was done by marking their route with the time next to it. Once this 'baseline' was established, the participant began to address issues that are still outstanding in their opinion. The strong feature in their visual expression is the intuitive application of Shneiderman's mantra [277]:

- Overview



(a) [P4 - Study 1] Participant Four uses a map to represent the whole journey.

(b) [P4 - Study 1] Participant Four uses the map to highlight detail.

Figure 3.8.9: Examples of using multiple maps for exploration and development of expression

- Zoom and filter
- Details on demand

By this I mean that they situated themselves by starting with the whole route, they then picked sub-areas that they box-lined and further explored in the next couple of maps. After the third map, the process started anew. While the map augmenting outputs were sparse, the participant was noticeably more creative in the drawing exercise. They used hue, layout, geometric shapes, punctuation, and icons to communicate their outlook. Like participant 2 the subsection 3.8.1, they presented positive and negative aspects separately. They used coloured paper for encoding and followed this up by assigning different colour pens per section Figure 3.8.2a.

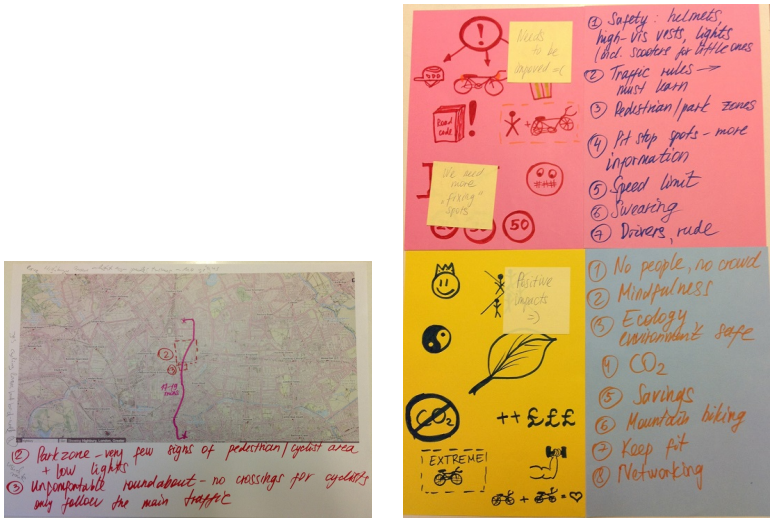


Table 3.8.2: [P4 - Study 1] Participant Four simple map marking as grounds for bolder free expression.

3.8.4 PARTICIPANT 5

"*I want to find an alternative path, instead of going for the faster way. I want to enjoy the surroundings and the park nature. "* At first, it seemed that the fifth participant misunderstood the task. They produced twelve maps and the comments on the Post-it notes implied that the tasks they had been performing were evaluating the maps for navigation. They marked the routes, often the same one, and made just a mark or two per map. However, valuable observations surfaced in the interview:

- Canal path looks inviting but scary
- The participant is a newcomer to London and is not familiar with the level of traffic in different neighbourhoods and on different roads. This would be useful information for people new to cycling and new to London.
- How possible is it to get refreshments on a certain route? People with invisible disabilities, like diabetes, might be very dependent on this type of information.
- When planning routes and outings, it might be interesting to have information on how long it takes to cycle local segments.

The participant modified the eleven maps they chose sparingly. Their expression consisted of four variations of lines, some lettering, and a mark. They used several hues but this does not appear to have been context related. It appears that they used colour to signify a new thinking avenue, i.e.; a new topic - a new colour.

In contrast, the drawing they produced was a vibrant map of what they consider an imaginary cycling environment. The process this participant has undertaken and the insights they shared, reminds us of user involvement when it comes to design as this participant has brought forward a set of new considerations (invisible disabilities, newcomer issues). It is evident to an extent that I have underestimated how much maps and visualisations situate users in our representation and lead the direction of their outputs.

3.8.5 PARTICIPANT 6

"*...it is busy, there are not many trees or anything along the cycle route, so it is a good cycle route but it is unpleasant.*"
This participant was consistent in their use of colour. They allocated classification to several hues and used this consistently in all of their map augmentations. While the majority of their output was mapping journeys and road classification into 'good' and 'bad' roads for cycling, they included icons and pictorials in three out of eight maps they augmented. In these, two out of three had novel icons that the participant devised. The participant seems to identify strongly with the environment as they used the shape of the landscape and converted it into icons Figure 3.8.10.



Figure 3.8.10: [P6 - Study 1] Participant Six identifies strongly with the landscape that provides joy.

However, in their sketch, they focused on the infrastructure and gave both positive and negative examples. All the examples are connected by meandering light lines which the participant stated to indicate the possibility of linked, different routes.

3.8.6 PARTICIPANT 7

"*Cyclists and pedestrians are free. So, that's a good thing. We have more opportunities in London. "* Participant Seven did not want to engage with maps. They see maps as irrelevant to their life and expression. They maintain that they use maps rarely, and then only in mobile navigation applications. Even then, they try to avoid them. Their sketch was a montage of pictorial concepts, which were expressed in the form of mini-stories. We have discussed them in order of importance but that is not how they are laid out on the page. The participant uses conceptual symbols, such as Tube signs to support their narrative. They use signifiers and their use of colour is consistent.

3.8.7 PARTICIPANT 8

" *I sort of forget to check where I am and then I find myself in the middle of a busy street.*"
Participant Eight augmented four maps, starting with their commute. They used colour and texture to communicate nuances regarding the commuting environment. For example, they assigned the colour red for negative aspects but further refined this by using a series of crosses for some paths and wavy lines for different ones. Like participant two, they attempted to communicate a sense of neighbourhood.

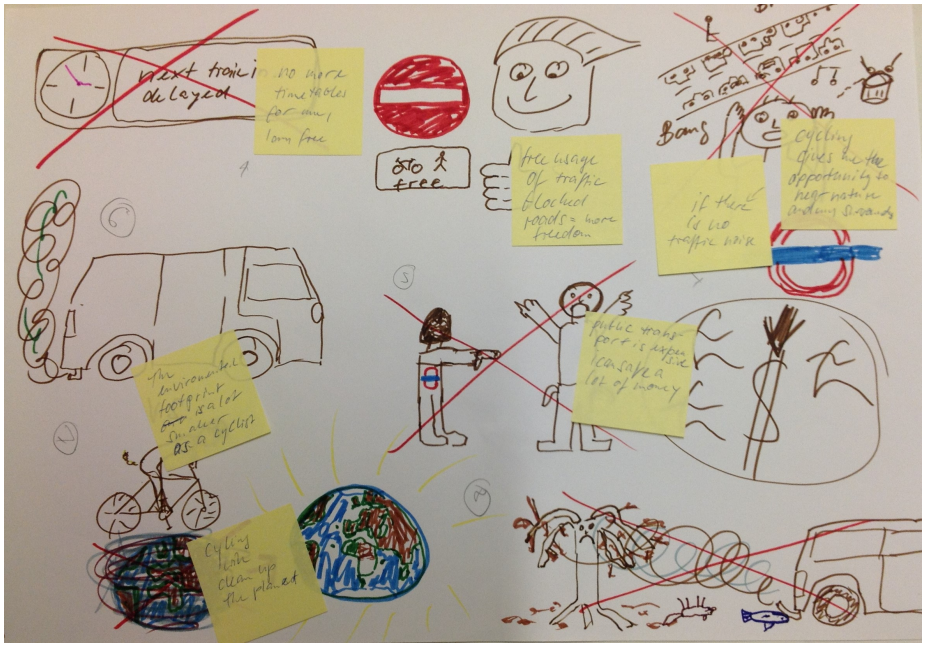


Figure 3.8.11: [P7 - Study 1] Participant Seven produced a montage-sketch. I added a number next to each concept we discussed as they ranked them in order of importance.

In map one, this is done in two ways. In this example Figure 3.8.12 the arrow with the number one is pointing to the area they commute through. The participant's notes say that they love the straight route but that this is an area "OK to get lost in." The perpendicular lines mark that neighbourhood but they also convey something about the area, as the participant uses a map with fewer features, where roads are more starkly visible. They stated that this is for the express purpose of communicating to us their love of residential streets Figure 3.8.13. They also marked them with straight lines. This is in contrast to the neighbourhood marked two in the map Figure 3.8.12, which is bound by a jagged line. I speculate that the straight lines were used for uniteruped, straightforward experiences and jagged lines for areas of friction.

In their sketch, this participant made an imaginary map map of their cycling stress levels
"*This is not really a route, but it's sort of almost like my... I thought this would be my heartbeat. And I'm cycling and in a way... yes, of course when you cycle your heartbeats, but this is more about my stress level, I guess.* " They added texture to lines to manifest what they perceived as stress levels. They used colour consistently and effectively.

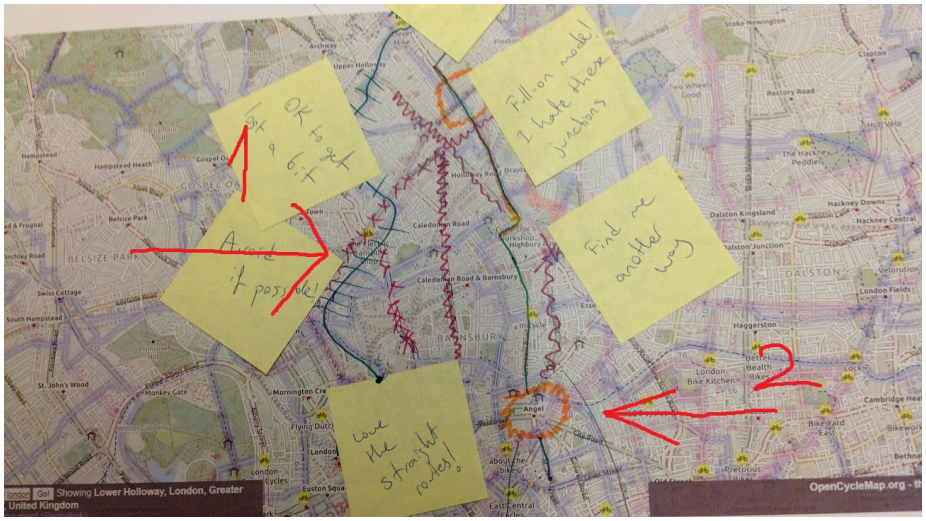


Figure 3.8.12: Participant Eight uses texture to communicate different feelings the environment provokes while they cycle through. The arrow number one points to the route with positive experience, while the second arrow points to the route with a negative experience.

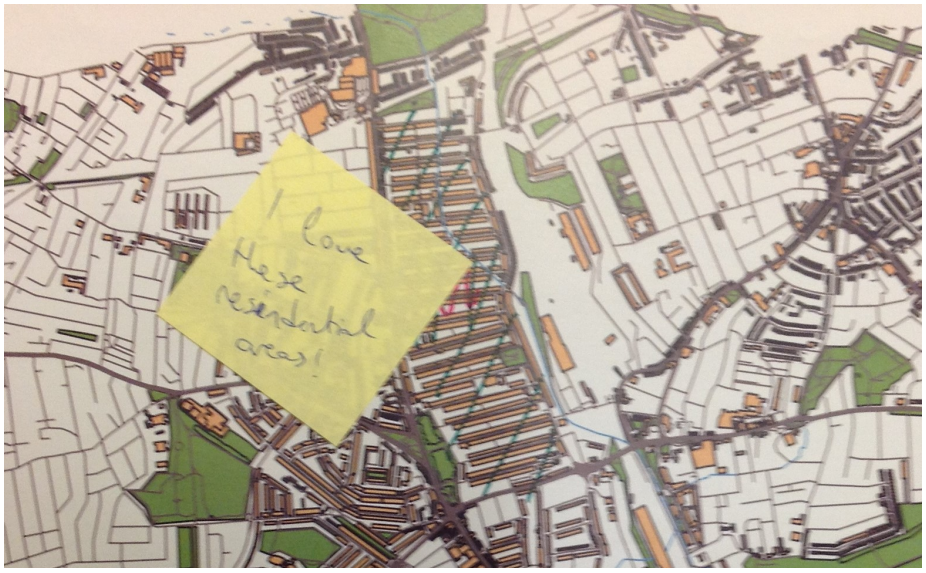


Figure 3.8.13: [P8 - Study 1] Participant Eight portrayed their commute. They used two different ways to mark neighbourhoods depending on what they were communicating.

3.8.8 PARTICIPANT 9

" *...my bicycle for me is the freedom to travel*"
Participant Nine wanted to express the phases of a single journey, their commute to work. They accomplished that by using different maps for sections and one map for overview. The maps this participant chose differ in many aspects as do the journey

segments represented. The first map is devoid of symbols and visually dominated by green spaces. The participant chose this map for the start of their commute, which they described as positive.

"*Beginning of the journey is always nice. It's always full of promise, it's the best bit.*"
The relationship between colour and emotion is well explored in literature [236, 160, 333] and the participant uses green and yellow to communicate the positivity of the journey. They also inserted a series of triangular pointers that are in line with the direction they are taking (Arrow 1 Figure 3.8.14), indicating forward movement. This is in contrast to the colours used for the rest of the journey (red, blue, and black) and the position of the triangles, which are placed perpendicular to the route, and give the route a jagged look (Arrow 2 Figure 3.8.14).

Their sketch is a montage that consists of both positive and negative aspects of cycling and contains themes addressed within the maps. However, the balance is here reversed as in the augmented maps, which had a greater proportion of the challenges represented. In Figure 3.8.15 I have marked positive associations with a plus in a circle and negative ones with a minus in a circle. The positive associations outnumber negative ones by four to two.

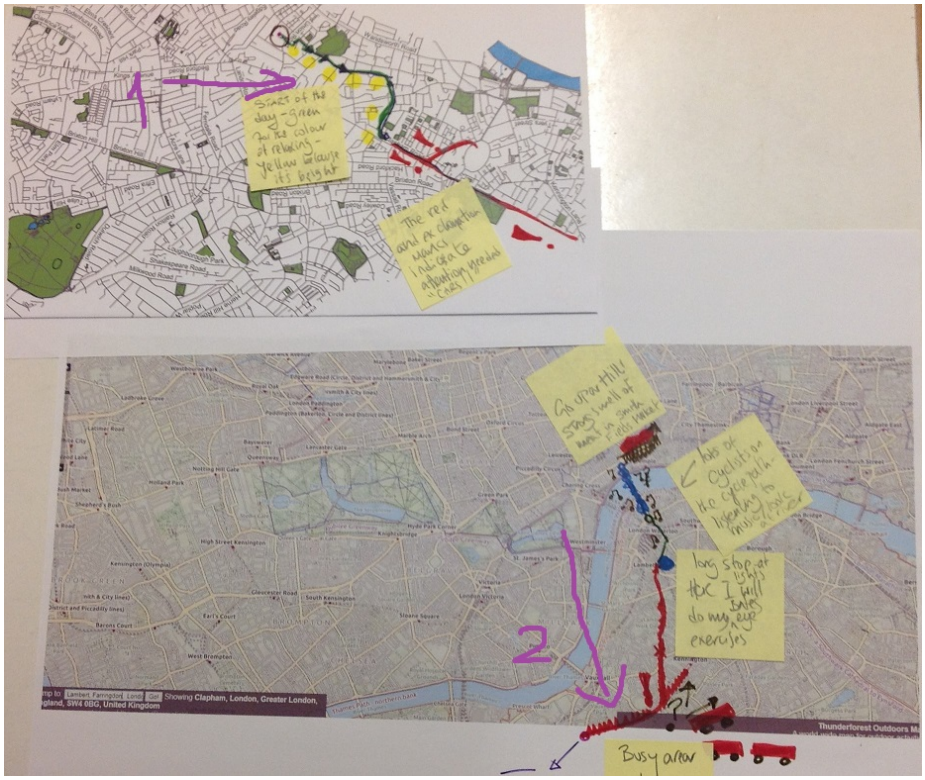


Figure 3.8.14: [P9 - Study 1] Participant Nine combined maps to form an entirety of the journey.

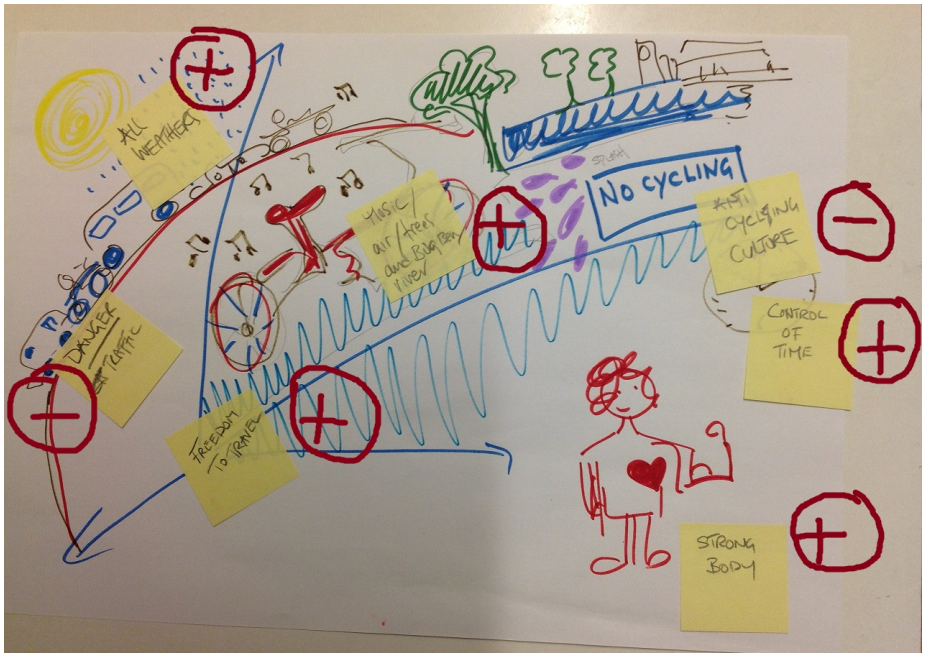


Figure 3.8.15: [P9 - Study 1] Positives outweigh the negatives in this sketch by Participant Nine.

3.8.9 PARTICIPANT 10

"*So basically I drew these next pictures because of what I was seeing on the map and then remembering my experience.* " Participant Ten was quite significant as their straightforward communication helped unlock some of the behaviours which I could then generalize to other participants, as it is the type of output that I have seen other participants produce, but not in such an explicit fashion. During the initial transcription and digitization of materials, I noticed the sparse and repetitive nature of this participant's interaction with maps. This contrasted with the vibrancy and volume of their drawings. The participant modified 5 maps, out of which 4 depicted the same journey in a very straightforward way Figure 3.8.14. After interacting with maps, the participant went on to produce five scenes Figure 3.8.16 and Figure 3.8.17 which were rich in detail and vibrant.

Observation of this behaviour has led to the conclusion that the participant used the maps to directly re-cue the experience of travelling the route. This was explicitly confirmed when listening to the participant's interview. "*I drew these next pictures because of what I was seeing on the map and then remembering my experience*" The scenes represented experiences and themes from the rides explored in maps. Each map revealed a different aspect of riding on the same route.

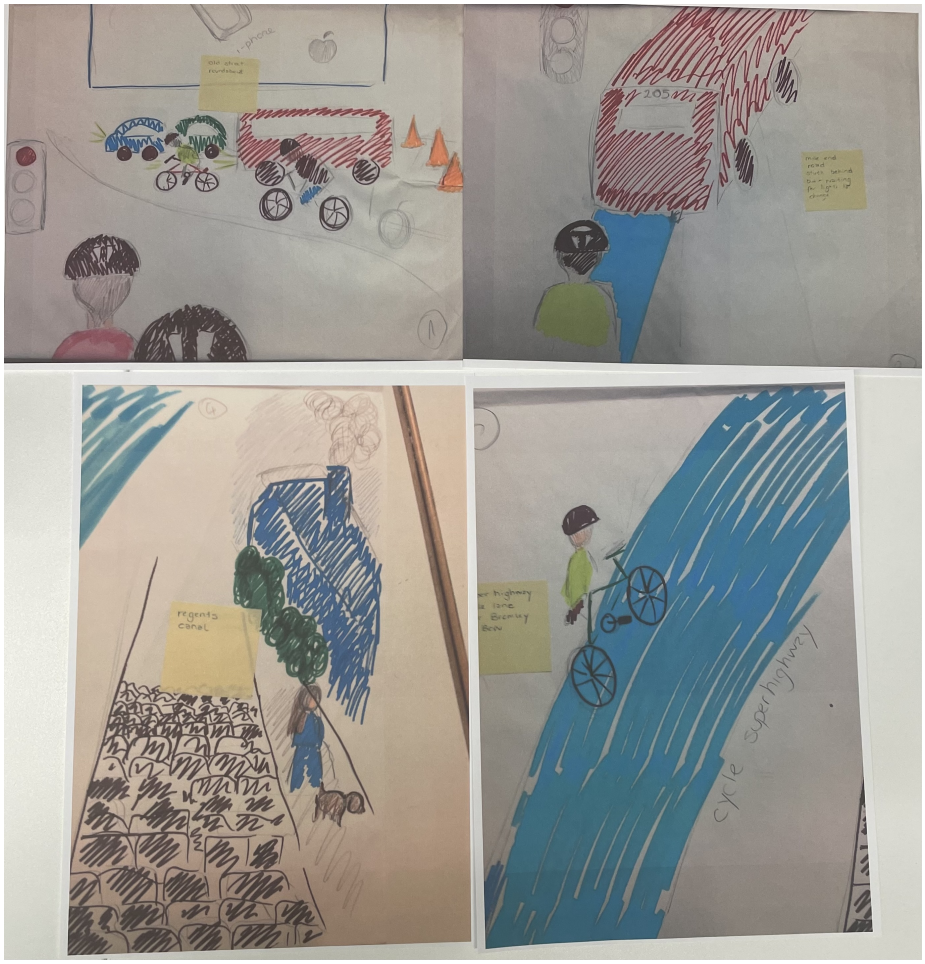


Figure 3.8.16: Montage of four sketches the participant has produced at the end of the session.

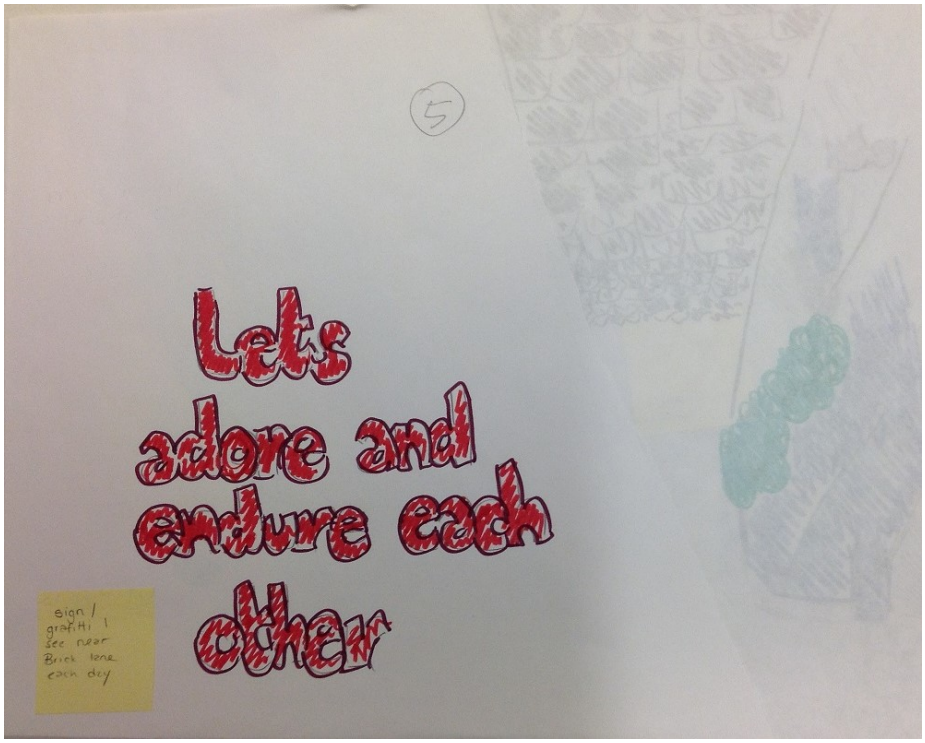


Figure 3.8.17: [P10 - Study 1] Montage of four sketches Participant Tent has produced at the end of the session.

3.8.10 PARTICIPANT 11

" *So this the choice, the sort of, I like the whole choice of cycling from where I go.* " Participant Eleven wanted to communicate their commute to work and the complexities surrounding this. They approached this by mapping their journey onto a Google map and augmenting it with pictorials and icons. They then created two separate sections that they wanted to add to the 'main' map. The sections are not connected by a line, and the route drawn on the Google map does not smoothly continue. Instead, they appear to be short studies of the area. The participant uses pictorials to communicate their message and the colour is in service of that.

Their sketch is an idealized presentation of things they love about cycling and it is depicted in an imaginary setting. The participant here also uses pictorials and there is no inclusion of the negative aspects.

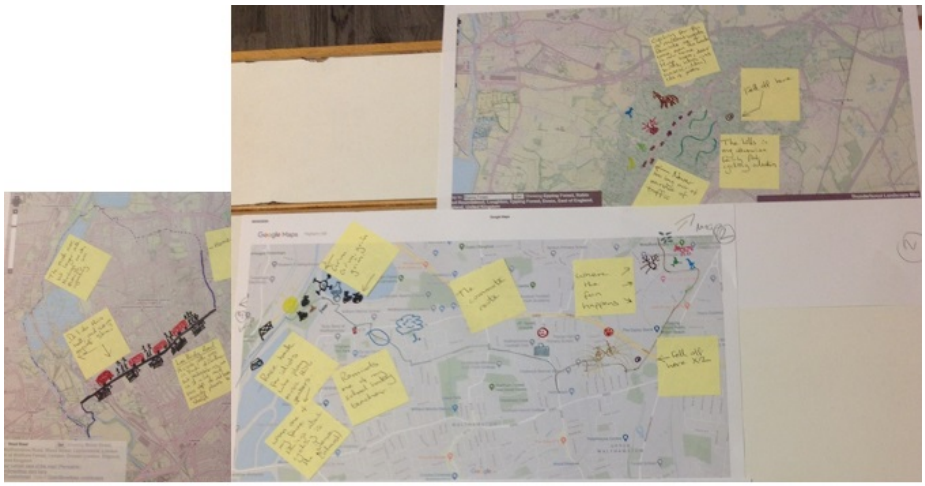


Figure 3.8.18: [P11 - Study 1] Participant Eleven used three maps to depict the entirety of their commute.

3.8.11 PARTICIPANT 12

"*When I go out with my friends, cycling is fun.* " Participant 12 was the only student participant. They are a foreign student and a newcomer to London. When they arrived at the session, they were reluctant to engage but as the session progressed, they became increasingly animated. They spent a long time with maps and seemed absorbed. Their augmentations were sparse and they produced only three, all separate routes, consisting of a simple line mapping the particular journey.

However, the sketch they produced was a clear contrast to the simplicity of the maps and was a sophisticated montage sketch, where scenes relate to each other.

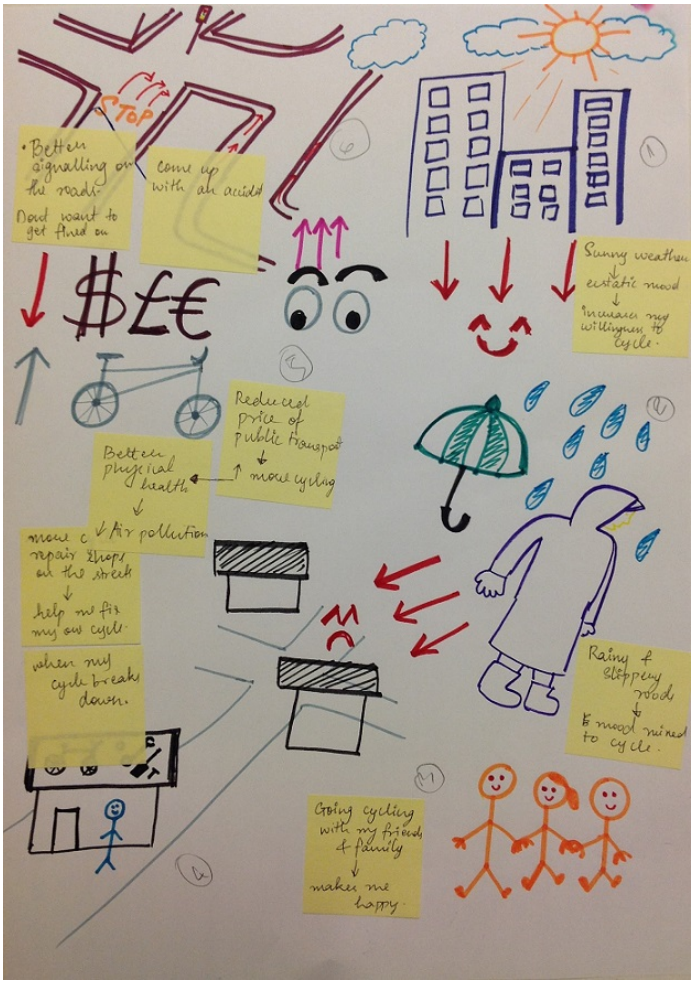


Figure 3.8.19: [P12 - Study 1] Participant Twelve produced a sophisticated sketch where elements relate to each other.

3.8.12 PARTICIPANT 13

" *I would appreciate if there would be more signs that the parts are dedicated only for cyclists. So no cars only, only bikes.* "(sic) Participant thirteen was the least engaged of all participants. They did not like using maps and perused them perfunctorily. They engaged with the most visible feature on the maps, which is borough names on the Google map and bike-shop signs, which are highlighted in yellow on the cycle map. The third map they used was not augmented, even though they communicated the importance of road signage that would help with orientation and finding the bike maintenance hubs. The one feature that they did sketch was a shortcut on the map one Figure 3.8.20.

Their sketch is a sketch montage consisting of three sections

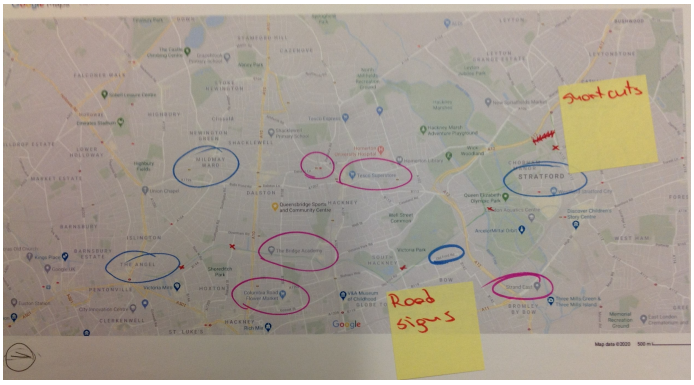


Figure 3.8.20: [P13 - Study 1] Participnat Thirteent's minimal augmentation of a map.

3.8.13 PARTICIPANT 14

" *The roads aren't good, but it's a nice, relaxed place to cycle. Because you just feel like you're just... it's very quiet. Its lots of nice houses and you're just cycling through.* "(sic) Participant fourteen is a nursing student who travels by bicycle privately as well as commuting to her nursing placements. Nurses do shift work so they have experience of the city that is unique, as they witness a fuller picture that is not confined to one temporal slice. This participant augmented five maps and produced one sketch. From the first augmentation, they developed their own visual language that they carried throughout. Some of these are a drawing of a Sheffield stand with a key for bike parking, and a green leaf signifying cycling green credentials. However, the most sophisticated is the way the participant represented pedestrians. For this, they used orange dots and the density of the dots conveys how busy the area is. These features can be seen in Figure 3.8.21. Additionally, this participant used the map's clear border to add a continuation of the path that is what they consider an ideal cycle path, and which contrasts with the existing provision. The two versions are marked with numbers one and two in Figure 3.8.21.

The participant interacted with another four maps, each depicting a different route. Their visual expression remained consistent, in that they used the same symbols to signify the same concepts and colours on all the maps. The first two maps they produced contained the most detail and information, as the amount of content, reduced with maps three, four, and five. The sketch they produced at the end of the session is an idealized scenario containing some of the elements from the maps but not as sophisticated or complex as the scenario they created on map one.



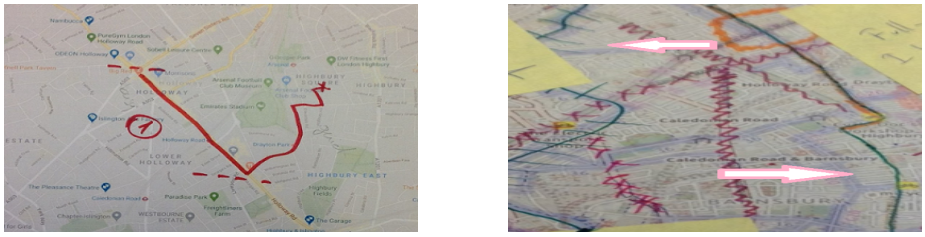
Figure 3.8.21: [P14 - Study 1] Participant Fourteen created a complex and sophisticated rendering that contrasts the current environment with the idealized one.

3.8.14 Analysis of Augmented Maps

This section of the thesis will examine what visual stimuli the participants have used, and how they expressed themselves. The thematic coding and analysis will be performed on the interviews and this will be the main source of the themes. Some thematic occurrences and insights will be discussed in this section as it is difficult to separate the two entirely.

In preparation for the session, I asked participants which areas of London do they cycle ordinarily, and then prepared maps depending on the answer. All the areas mentioned were rendered in all 16 types of maps. Where there was a need to produce several maps for a single area/journey, I made sure that there was overlap at the edges, so that participants could identify where the map finished and find another, in case they wanted to *combine maps*. Two out of fourteen chose to do this and they both combined types of maps. The first participant (subsection 3.8.8) chose a different map as they wished to show one area with greater clarity, while the other participant used what they deemed as similar maps (subsection 3.8.10).

Thirteen participants engaged with maps and chose the map augmentation as the first activity. One participant did not engage with maps at all and only produced a sketch (Figure 3.8.11). Shwartz and Kulhavy [269] show that in combination with narratives, maps containing features improve recall. The maps used in the study were divided into two sub-groups; the 'traditional' maps which included man-made landmarks such as railway lines, supermarkets, hospitality places, etc. (depending on the map), and the maps I created where there were no such landmarks. By dividing them in this way, I wanted to see if the participants had a preference between feature-rich maps and maps that convey basic information such as roads, names, and green areas.**Participants prefer feature-rich maps**. The most used maps are Google, Cycle map, and the map containing roads, houses, green spaces, water, and street names ('Roads, Green Spaces, Water Names'(RGWN)). No participant opted for using only ready-map, or only custom-made maps. If we look at the overall number of maps used, by map type, Google maps were used most often as 15 maps were used, followed by Cycle maps and 'Roads, Green Spaces, Water Names'(RGWN) maps. **All the participants used a variety of maps.** The least used maps were the maps with no road names, followed by Satellite maps. When asked about the reasons behind the map choice, participants said that ready-made maps look the way maps should be, implying the participants find culturally embedded practices helpful bridges for translating their actions into two-dimensional space. For the particular choice of custom maps, the reason cited was the clarity and accessibility of street names.

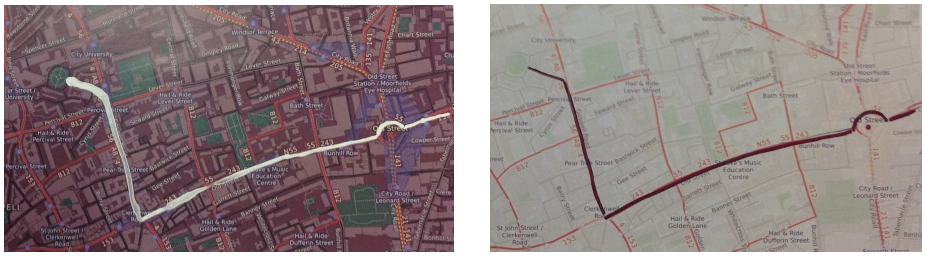


(a) Principle of (b) Figure 2

Figure 3.8.22: Two figures side by side

Exposing participants to a variety of maps, most of which were not created with cycling in mind, has resulted in some surprising results. For example, the dark transport map subsection .1.4 has reminded participant ten subsection 3.8.9 of the seasonality of cycling conditions and its challenges, which they included in the five sketched scenes they have created Figure 3.8.16 following the engagement with the maps. The bus numbers on the OSM Transport Map inspired participant five subsection 3.8.4 to reflect on the possibility that a map with cycling times would be helpful for people new to the city.

Five out of fourteen participants did not embellish maps and either only marked routes or circled already present features, while two participants produced both richly augmented maps and a number of less-augmented ones. Further analysis revealed that four participants exhibited an interesting trend in that they marked the same route in a similar fashion on a number of maps. While there were no copies of



(a) The commute depicted on the OSM Dark Transport map.

(b) The same commute on the OSM Daytime Transport map.

Figure 3.8.23: An example of **map-riding** as the participant has produced several representations of the same route without embellishments. The same participant has produced several free-hand sketches following their engagement with maps.

exactly the same map, there were copies of the same type of map at a different zoom level as well as there being similarities between maps, as can be seen in the description of the features: Table 3.4.3 Table 3.4.3. The participants had an opportunity to do all their work on the same type of map. We can see an example of this behaviour in Figure 3.8.14 as the participant has drawn exactly the same route on two very distinct maps. In actuality, this participant repeated the route on four maps. Each map would be a recollection of the journey under different conditions. **This behaviour, which I call map-riding shows that the engagement with the maps and the type of map is important, in that map content and layout stimulate participants to consider aspects of cycling that they might not have otherwise.** Participants four, ten, twelve, and fourteen all engaged in map-riding and used thus gathered insights to produce their drawings which were in each case either numerous, full of content, or both. **Participants that use a variety of maps to explore the same journey produce richer sketches.** We see a clear example in participant ten's outputs, as discussed in subsection 3.8.9. One of the participants has described their interaction with the maps as: "*... I was just drawing lines of my route, to and from work, more than anything, and just while I was thinking what to draw, I guess.*"

Another observed type of behavior is **feature latching (FL)**. Feature latching is when a participant does not look beyond what is already present on the map and it is in contrast with content-building, which is adding features to the map. Examples of feature latching include maps where the participant has only circled icons Figure 3.8.24 or place names, as well as constraining the output to double-encoding the existing features, such as drawing trees on the park.

FL has implications on research, as it indicates that research involving maps can be influenced by the judicious choice of representations, in that people might constrain their answer to what is presented in the map and not go beyond that. Feature presentation can be accidental, in that we design features that we do not expect participants to embrace. A good example of this is one of the most basic maps available, which was a monochrome of roads. One participant noted a roundabout that was present in a corner of the map. In the interview, they commented that they found the map confusing due to its bare simplicity and that the confusion made them mark the roundabout. That particular roundabout was present on at least a

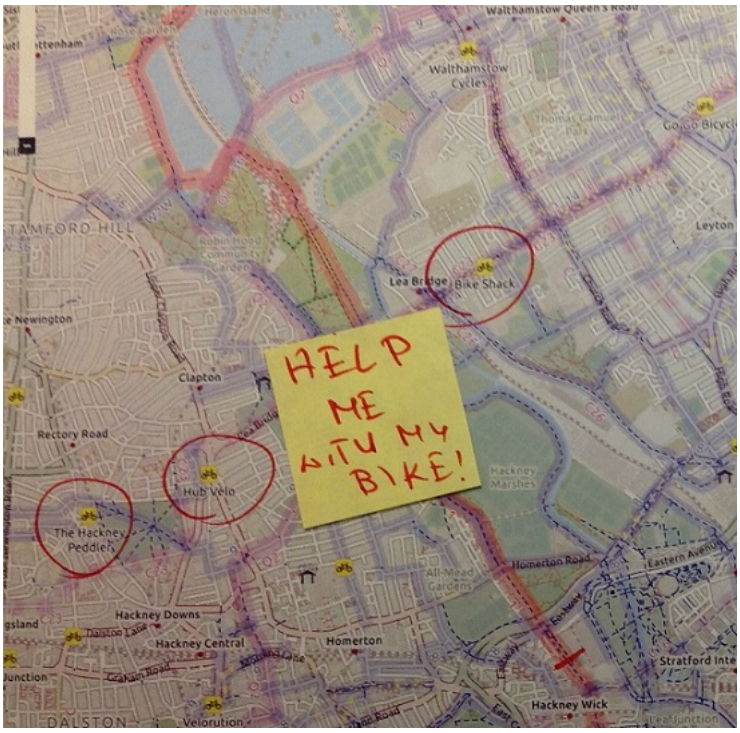


Figure 3.8.24: An example of participants constraining their output to circle the existing map features.

quarter of the maps available to the participant, and a number of the maps that the participant used. However, the confusing effect of negotiating the complex roundabout has been marked only once and was brought to the participant's attention not by its presence, but by their observation of the map's accessibility.

3.8.15 Analysis of the Augmented Maps - Visual Content

PARTICIPANT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	SUM
USE OF LINE															
SIMPLE LINE															0
TEXTURE															9
BOUNDING															8
SYMBOLS															
PICTORAL															6
NEW SYMBOL															6
ICON															5
MARK															5
PUNCTUATION															5
ARROW															4
COMBINE TO MAKE NEW															4
WORDS															4
ROAD SIGN															3
USE OF COLOR															
COLOR															7
FEATURE DUALITY															4
TREATMENT OF MAPS															
MAPPING JOURNEY															12
AREA															6
FEATURE MAP															5
COMBINED MAPS															2

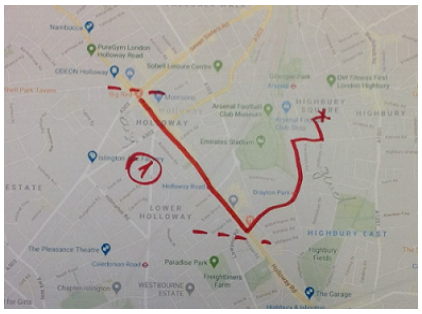
Use of visual expression and map use per participant.

PARTICIPANT	SUM
USE OF LINE	
SIMPLE LINE	12
TEXTURE	9
BOUNDING	8
SYMBOLS	
PICTORAL	6
NEW SYMBOL	6
ICON	5
MARK	5
PUNCTUATION	5
ARROW	4
COMBINE TO MAKE NEW	4
WORDS	4
ROAD SIGN	3
USE OF COLOR	
COLOR	7
FEATURE DUALITY	4
TREATMENT OF MAPS	
MAPPING JOURNEY	12
AREA	6
FEATURE MAP	5
COMBINED MAPS	2

Total for all users.

Table 3.8.3: Table depicting visual expression and the use of maps per participant as in what the participant and the sum total for all participants on the right.

Just as in their behaviour when choosing maps, the participants exhibited patterns in the treatment of visual channels. Participants used some traditional and some non-traditional devices to communicate. As can be seen in Table 3.8.15, I have divided the outputs of participants into expressiveness; the use of symbols; the use of colour; and the treatment of maps.



(a) Principle of continuity.



(b) Principle of similarity.

Figure 3.8.25: Participants intuitively used Gestalt design principles [169] such as the principle of continuity Figure 3.8.25a and the principle of similarity Figure 3.8.25b.

Expressiveness This section examines the marks that cannot be categorized as icon or a symbol. As per Cleveland and McGill, graphical perception is achieved by; the detection of geometry; assembly which helps us discover overall patterns in data; and estimation, by which we can assess a relative value [56]. Hence, we are

categorizing expressiveness in two ways: by their geometric properties and the role played in what the participants were communicating.

By geometric property, the expression can be divided in:

- **Closed lines** - these are the lines used to circle features or areas. They tend to be circular but can be angular or irregular in shape.
- **Texture** - the examples are lines that are wavy dashed and enhanced, as well as textures added to an area.
- **Simple line** - these are simple lines without embellishments and can be single or multiple.

They were used to communicate:

- **Hierarchy** - hierarchy can be a preference, like a route that is preferred, or quality of provision (good road- better road). With hierarchy, we can order items.
- **Classification** - can represent emotional classification or complexity of experience. With classification, we cannot order items. If participants love one location but hate another, they are in two classes that cannot be put in order.
- **Emphasis** - is also an ordinal value and it communicates a level of importance.

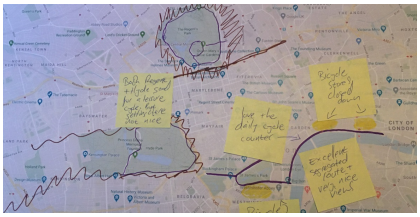
An example of *hierarchy* is the marking of a primary and secondary route in Figure 3.8.26a. The participant used the full line for the main section of the route and a dashed line for the optional, long way. *Closed lines* was the most frequent application as it can be used for delimiting everything from areas to icons and words. It puts *emphasis* without requiring the mental effort of representing the detail and is the most general type of communication used (signposting). Participant thirteen used bounding by closed lines almost exclusively Figure 3.8.20.

In the Figure 3.8.26b we can see an example of texture being used for classification. This participant used a simple line for some of the routes, where experience did not require much elaboration (referencing interview) and a wavy line to mark routes that have multidimensional factors influencing the quality of experience. The wavy line indicates the environment surrounding the route. Also, texture can be used to communicate emphasis and emotion. In the example Figure 3.8.26d, an irregular pattern, with acute angles was used to communicate a strong dislike for the specific area.

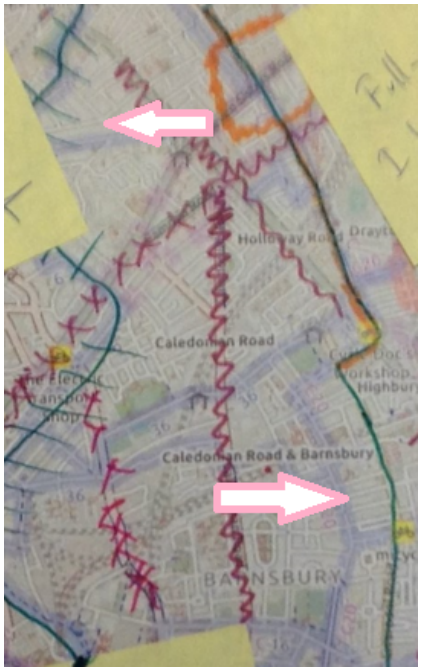
Simple lines can be used to produce an effect and communicate elements of the experience. In the example Figure 3.8.3, two simple lines were used parallel to each other to indicate different environmental settings at different times of the day. Participant Eight used an array of textures to give a hierarchy to the routes; from preferable to ones they hate, but has also used simple lines effectively. In the Figure 3.8.26c, we can see that they have put a series of perpendicular lines along a



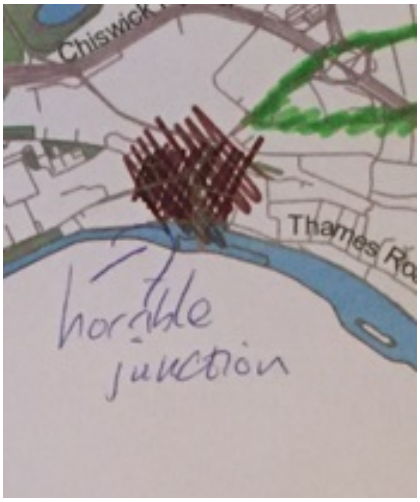
(a) Texture to depict hierarchy. The solid line is the primary route and the dashed is an alternative.



(b) Texture for complexity and classification. Here a participant used two types of lines to draw routes. The simple lines depict experiences that are not challenging and straightforward. The wavy line depicts a more complex experience that is determined by multidimensional factors.



(c) The participant uses texture to assign hierarchical order to the roads (good, bearable and hate) but also uses Gestalt principles of similarity and continuity to add information.



(d) Texture used to emphasise negative emotion.

Figure 3.8.26: Examples of visual expressions and their application.

good route to indicate that this ranking also applies to the roads in the vicinity. In doing so, they used Gestalt principles of similarity and continuity. We can see other examples of Gestalt in Figure 3.8.25 where one participant achieves the same effect as participant eight, with fewer lines and higher abstraction. while another uses assembly [56] to create a complex sentence about an area.

Participants used lines more for marking an area than for emphasis. Possible reasons for this are that marking an area, in a way that is not bounding, obscures the content of the map and puts participant's augmentation on the forefront.

The use of Symbols. The classification of the symbols has been addressed, in-depth, in the section 3.6. However, during the study of the materials, it has become evident that there are a couple of concepts that need to be included in the analysis. These are:

- **New Symbol** - these are the icons and symbols that is not road -sign or frequent emoji (for example a symbol for the wind).
- **Combining symbols** - drawing symbols closely together in order to communicate complex themes and applying the principle of assembly to the audience [56].

All of the participants used symbols to a certain degree. The most widely used were pictorial depictions, where participants drew sketches of the items and concepts they wished to represent, and the creation of new symbols. A good example is participant number two. They wished to communicate concepts that are not traditionally mapped and developed their own marks. The said concepts are wind, uphill, downhill, and memory-invoking Table 3.8.1. While memory and wind are not considered spatial concepts, for the participant, they are closely bound to the geographies they pass through.

Thirteen participants augmented maps by writing over the mapped areas, but for participant three, maps were not sufficient. This participant arrived in the UK recently and finds the climate harsh and unpleasant. Hence, they have not embraced urban cycling, as London is a different environment to the one they are familiar with, and they train using a stationary bike. Despite this, they explored maps and situated themselves by finding their home neighbourhood and workplace. They built on this by using the map margins to embellish the maps with pictorials of their connection and attitude towards cycling. The same expression style was continued in their drawing, which comprised a number of cartoon icons Figure 3.8.8.

Participant Fourteen used arrows to great effect. They modified the arrow representing uphill to a series of arches depicting the effort required for every revolution of the pedals during an uphill climb. In contrast, they kept the shaft of the arrow pointing downhill straight Figure 3.8.27.

Use of colour Seven out of thirteen participants used colour with purpose. This means that they either consistently used the colours to represent the same features on multiple maps, or they used the colour for emphasis. The latter was more frequent as only three participants did not vary their colour assignment (P6, p9, and



Figure 3.8.27: The participant uses different arrow shafts to contrast speed and effort.

P14). When asked about the colour assignment, the rest of the participants said that the choice was either random or depending on which pen was closest to hand.

The colour was used to represent feature duality (one feature being experienced differently in different contexts) and it [produced **conflicting encoding** . An example of this is when a location has both positive and negative aspects and hues signifying both are used on the same feature. For example, Richmond Park is both very pleasant and dangerous, depending on the time of day and the week. We can also see feature duality in the Table 3.8.1. In the Downhill picture, the same stretch of road is marked as downhill positive (red) for fast, and negative (blue) for dangerous.

While some participants used colour with intention, the most common behaviour was to punctuate theme change with a random colour change. further work, exploring this particular aspect could help ascertain to which degree was the colour choice truly random or if there is an underlying association.

3.8.16 Analysis of Sketches

All the participants were asked to express themselves on blank paper, whether they engaged with the maps or not. The reasoning was that I wanted to give them a chance to express aspects of cycling that are not spatially constrained. The participants had a choice of materials and the order they engaged with the materials. All the participants, bar one, chose to engage with and augmented the maps first. As the sketches followed the maps, I expected the content to be the same. I analysed the sketches regarding how they related to the maps and what themes the participants chose to present.

In the first stage of analysis, the analysis is in relation to map content. I looked at whether the concepts depicted in the sketches differed from the ones depicted on

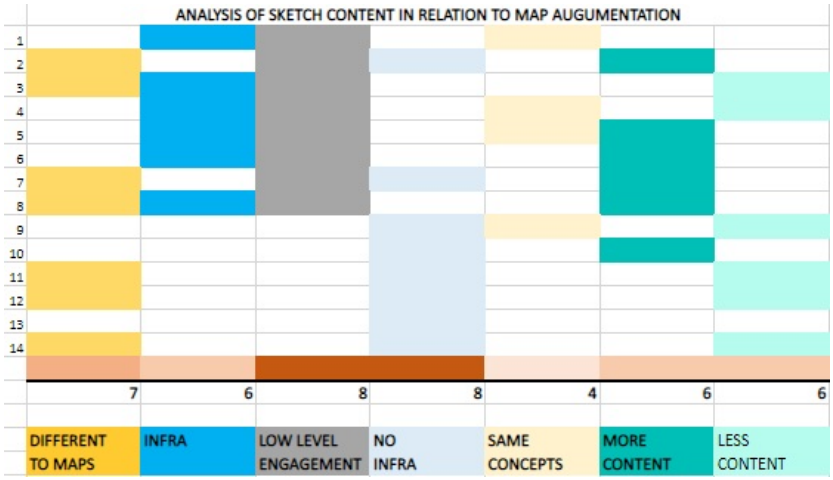


Figure 3.8.28: Table of data gathered in the process of comparison between the sketches and map outputs. The variable 'Low-level Engagement' (grey) represents the level of augmentation in the maps. To the right and left are variables that capture whether the sketch depicts cycling infrastructure (darker blue) or other aspects of cycling (light blue) and whether the concepts depicted are different from the map augmentations (orange) or the same (pale yellow). On the far right are the variables capturing whether the sketches contain more content than the map (darker teal) or less (pale teal).

the maps; whether there is more content in the maps or sketches, and whether the participant described the infrastructure. In the maps, I looked at the level of augmentation, in other words, if the participant constrained their output to bind and map the journey, or if they added, built-up and enhanced, the existing representation.

If we look at the table in Figure 3.8.28, we can see a clear relationship between the treatment of the maps and the placement of infrastructure into sketches. *Participants who engaged with the maps less (grey column in Figure 3.8.28), tended to represent infrastructure (darker blue column in Figure 3.8.28) in their sketches more.* They were also more likely to repeat the content between the two outputs (pale yellow). Presenting the new content was equally distributed among all the participants. The last variable that I considered was whether the sketch has more or less content than the map augmentation. Six out of eight participants who used minimal augmentation had richer sketches than the map renderings. There appears to be a relationship between the way contributors engaged with the maps and the outputs they later produced.



Figure 1 Participant 2

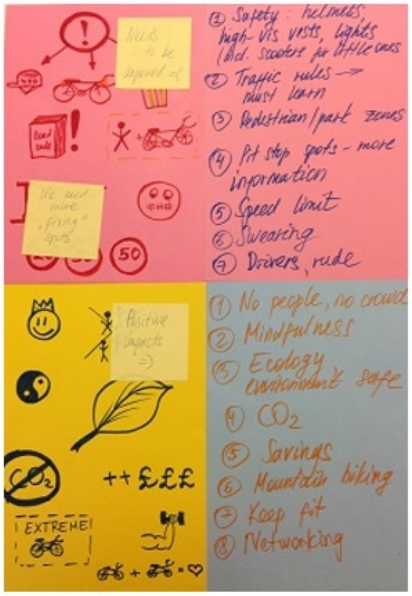


Figure 2 Participant 4

Figure 3.8.29: Sketches contrasting positive and negative aspects of cycling. Only two participants chose this type of expression.

As well as content, there was a clear difference in what participants chose to express in sketches. These fall into three categories.

- **Depicting positive vs negative** - with this type of expression the participant reflects on the positive aspects of cycling as well as the negative. We have only two examples with slightly different approaches. Participant two divided the paper with a diagonal line to separate positive and negative aspects. besides the line, there is no other encoding that would help a reader differentiate whether the concept has positive or negative connotations. On the other hand, participant four used coloured paper and a pen colour to differentiate the two. They also added text, as well as itemised concepts they depicted Figure 3.8.29.

- **A montage of scenes** - montages is a collection of scenes that differs from the positive-negative type of outputs in that there is no clear delineation or reflection on the pluses and minuses of cycling. The depictions are of positive aspects and positive associations. In the rare instance that a negative is depicted (participant eleven drew a figure in the rain, Figure 3.8.30 and one of participant ten's drawings depicted a towpath that is pleasurable in the summer but treacherous during the wet winter weather Figure 3.8.16), they are not presented in an organized way and in a way that highlights the difference. The output of participant seven Figure 3.8.30 at first glance appears to belong in the positive-negative class, as some of the scenes are crossed out in a red pen, but on further inspection, it becomes clear that these are the difficulties



Figure 1 Participant 3



Figure 2 Participant 11


Figure 3 Participant 10


Figure 7 Participant 7



Figure 5 Participant 9

Figure 3.8.30: Sketches formatted as a montage of scenes illustrating concepts participants relate to cycling. These depictions favour positive aspects. *Figure 7 Participant 7* appears like it portrays positive and negative aspects due to several crossed-out scenes, but the crossed-out scenes are the negative aspects of not cycling.

people who do not cycle face and are crossed out as cycling resolves them.

- **Imaginary cycling environment** - this is the most numerous type of sketch as there are six outputs in this class. They can be further divided into an *ideal environment* and a *summary*. An ideal environment (participants 11, 5, and 14 Figure 3.8.31) is a presentation of an imaginary route or a section of one, that the participant considers an optimal setting. Some of the contributing features are a company, sunny weather, cycling gadgets, good signage, and repair stations (to name a few).

  The summary sketch extracts points the participant has raised in the map augmentation, and presents them in a stylised fashion in the sketch. They differ



Figure 1 Participant 5

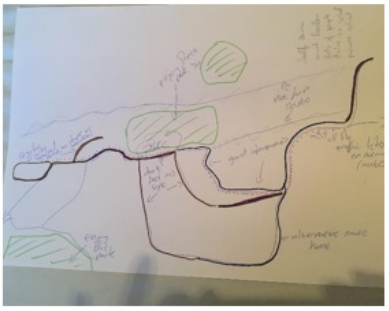


Figure 2 Participant 1



Figure 3 Participant 11

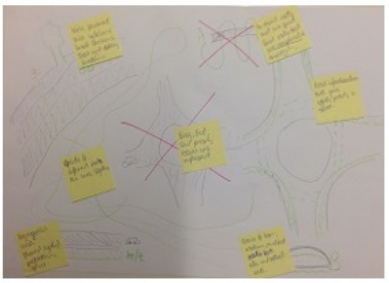


Figure 4 Participant 6



Figure 5 Participant 14



Figure 6 Participant 8

Figure 3.8.31: Sketches depicting an imaginary cycling environment. In the left column are the sketches depicting an ideal environment, while on the left are the sketches which are stylized summaries of the challenges and benefits.

from positive-negative sketches as their focus is on infrastructure. They have been rendered as an example of a route (Participants 1 and 8) or as examples of problematic infrastructure alongside the proposed solutions (participant 6). Summary sketches were produced by participants 1, 6, and 8 Figure 3.8.31.

3.9 Analysis of Text and Themes

Frequency by Mention					
Physical infrastructure		**Journey Execution**		**Experiential**	
Unsuitable Infrastructu	22	Longer nicer	10	Nature	20
Needs signs	17	Temporal/seasonal	13	Joy	11
Cycle furniture	11	Traffic	6	Pedestrian clash	11
Good infrastructure	9	Shortcuts	5	Freedom	7
Junctions	9			Unpleasant infra	7
Traffic lights	9			Cyclists clash	6
Shops	8			Beauty	6
Repair stations	8			Safety	6
Lack of links	6			Sounds	6
				Alert	5
				Convinient	5

Frequency by Participant					
Physical infrastructure		**Journey Execution**		**Experiential**	
Unsuitable Infra	10	Temporal/seasonal	11	Nature	9
Needs signs	9	Longer nicer	6	Unpleasant infra	6
Repair stops	7	Shortcuts	5	Pedestrians clash	6
Traffic lights	6	Residential streets	3	Beauty	5
Good infrastructure	6			Joy	5
Junctions	6			Independence	4
Shops	6			Sounds	4
Lack of links	5			Freedom	4
Busses	5			Traffic	4
Cycle furniture	5			Alert	3
Lacks infrastructure	4			Cyclist clash	3
				Convivient	3

Figure 3.9.1: The above two tables depict the most frequent themes from the interviews. The themes are divided into three classes depending on whether they are related to the physical infrastructure, the way participant travels, or how they experience their journey and its environment. The top table is ordered by the number of times a theme was mentioned, while the bottom one is by the number of contributors that mentioned it.

Thirteen out of fourteen participants engaged with maps and embellished them, adding and highlighting features. Some themes that the maps elicited were drawn, or marked, straight onto the maps. Examples are green spaces, cycling furniture, potholes, and even memories and wind (examples of these and other augmentations are located in the subsection 3.8.14). However, as we can see in Figure 3.8.28, eight out of fourteen contributors studied the maps, but their output, in terms of the richness of visual expression, was limited. Hence, I relied on the interviews for insight into what associations and thoughts the maps elicited. I did the initial theme identification during the transcribing of the recordings and later transferred this to the NVivo software, as it gave me a good overview of the themes and enabled me to

efficiently prune and merge them. I divided the remaining themes into three classes: themes that relate to the physical infrastructure, themes that relate to how participants choose to travel, and lastly, themes that relate to their experience of cycling and the cycling environment. The frequent themes are (in no particular order):

1. **Unsuitable infrastructure** - existing cycling infrastructure that does not serve its purpose well. Examples are cycle lanes that go over potholes or infrastructure that is only painted on.
2. **Longer nicer** - this is when the participants expressed that they prefer longer routes as they are either more pleasant or safer.
3. **Nature** - instances where participants commented on the presence of trees, water, plants, and parks.
4. **Needs signs** - instances where a participant has noted that signs would be of help, or talked about an area where they routinely get lost.
5. **Temporal/seasonal** - these themes cover instances where participants talked about cycling conditions changing depending on the time of day or season. These include winter cycling vs cycling during other seasons, cycling in term time when the schools are open vs cycling during school holidays, or cycling towards the same destination during the weekend vs weekday. It does not cover commuting vs leisure cycling.
6. **Joy** - this theme covers the expression of the good feeling that cycling can awaken in people who cycle.
7. **Cycle furniture** - this theme covers both mentions of good provision and instances where a lack was observed, as I am searching for themes that people who cycle find important.
8. **Traffic** - this theme covers instances of mentioning the words traffic and cars, trucks, vans, and motorcycles. Buses are treated separately as they often have their own lane in London and were getting separate mentions. This is also the case with other cyclists. Participants' relationship with other people who cycle was separated as they also tend to interact in locations that are not shared with motorized traffic.
9. **Pedestrian clash** - this theme covers instances where people who cycle discussed issues in regard to pedestrians. Most instances are on shared paths but pedestrians stepping out onto the roads between cars in busy areas are also included.
10. **Good infrastructure** - comments regarding good cycling provision.
11. **Shortcuts** - instances where participants have mentioned taking a shortcut, or that riding a bicycle enables them to take shortcuts.

12. **Freedom** - instances where the participant has observed that cycling gives them freedom.

13. **Junctions** - instances where participants have mentioned crossings and roundabouts.

14. **Unpleasant infrastructure** - instances where participants have described infrastructure that is structurally suitable for cycling but in an environment that is stark, unwelcoming, or unappealing in any way to them. In many instances, participants opt for an alternative route.

15. **Traffic lights** - instances where participants mentioned traffic lights. This may be the number of traffic lights in an area, the length of a traffic light, or its role in navigating a certain area.

16. **Cyclists clash** - the instances where participants described other cyclists negatively. These include racing at the lights, a sense of entitlement, aggressive overtaking, and verbal aggression.

17. **Shops** - this theme instances where participants described the presence of retail. This could be supermarkets, corner shops, retail malls, etc.

18. **Beauty surroundings** - this theme describes instances where participants remarked on the importance of aesthetically pleasing surroundings.

19. **Lack of links** - this theme captures instances where participants remarked on the lack of linking infrastructure in particular instances and as a general problem.

20. **Safety** - instances where participants expressed concern for their safety.

21. **Repair stations** - instances where participants remarked on the existence of a repair station or a bike shop and instances where participants expressed the need for more.

22. **Alert** - instances where participants observed the need to be extra vigilant while cycling. These instances were mostly connected to the traffic level or the time of day at the particular location.

23. **Convenient** - instances where participants identified cycling as a convenient form of transport due to its flexibility.

24. **Sounds** - instances where participants noted a presence or absence of noise or a sound. This can be hearing nature or a reference to noise pollution.

As can be seen in the section 3.9 two tables, the main themes participants discussed were *unsuitable infrastructure, remarks on nature in their surroundings, need for more signage, taking longer but more pleasant routes, seasonality of the routes and the joy they experience when cycling.*

The need for infrastructure is often discussed [127, 117, 10, 215] but the effectiveness of the existing provision tends to be overlooked. Infrastructure can be unsuitable for a variety of reasons from its width (four participants expressed the wish for wider cycle paths) to the level of pollution. Participant Eight remarked:

"*Then you have lots of air pollution. That's also not nice. I mean, being segregated. It's not enough. You also need to breathe.* "

On the other hand, Participant Eleven observed that unsuitable cycling infrastructure can be a deterrent for new cyclists and that cycle maps have a role in spreading misinformation, in that they inform people where it is suitable to cycle falsely:

" *And sometimes cycle paths are so narrow that it doesn't really even make any difference. They are very narrow roads which don't really make a difference like cars don't pay any, any difference to it, nor the buses. So yeah, I don't see really the point of it as, I think if someone has a bit of resistance to cycling and would have a look at such and such a map and decide; Oh, I will choose this way because I can see that that is dedicated to the cyclists they could be very much surprised as their experience could be very bad.* "

Many people devise their own routes and often choose longer ways to avoid a particular area. Participant Eleven said of their commute to work:

"*So I hate that bit. But do I go through that bit of hell? Or do I go almost five kilometres extra to go around on the nicer route?* "

It can be argued that such a keen experience of the surroundings is connected to the fact that cyclists are immersed in, and exposed to their environment. Things like the presence of natural elements like trees (9 participants remarked on it), the beauty of the surroundings (5 participants remarked on it), and even sounds they hear (6 participants remarked on it), have a great impact on their experience and enjoyment of cycling.

Another frequent theme was the need for better signage. Nine participants remarked that routes could be improved by the inclusion of signs for better orientation, for finding facilities, and for route planning, but in three cases, the need for signage was implicit. One participant remarked: "*Drawn lots of arrows around Old Street there because it's really confusing.*"

When it comes to the execution of the journey, the second most mentioned theme was the temporal and seasonal aspect of cycling (11 participants mentioned it). Here, the most discussed was the difference between summer daylight hours and winter hours. One participant described the impact on their journey in the following way:

"*And because it's a lot darker, though... And when it's wet, the cobbles can be quite slippery. And I don't feel as safe taking that route in the winter. Even though it is, on the flip side of that in the summer it's a lot busier, so there are a lot more people walking and a lot more cyclists along the canal, so but then it's just it just means it's a bit of a slower, but I don't mind that as much.*" Here we see that the route has distinct trends depending on the season. Some other participants described changes that depend on the time of day (for example passing a school at different times of day) or

passing the same route during the week or at the weekend (nurse on shift work).

Something that did not make it to the list of most frequent themes, but was mentioned, was the mental health benefits of cycling. The inclusion of it in this thesis is not based on the number of participants that addressed it explicitly (2), or the number of references (4) but on the strength of the language participants used when discussing it. For example, one of the participants remarked:

" *"...I do find a lot of things quite stressful about living in London, and for me, it is a real relief to be able to move and function in London. But for my bike, I wouldn't be able to. I don't think I would be at all well, otherwise"* "

3.10 Discussion and Conclusion

This was an exploratory study collecting outputs from fourteen individual sessions in the form of augmented maps, sketches, and recorded interviews. The augmented maps and interviews were analysed independently, in their own right, and not in relation to interviews or other outputs, but the sketches were analysed both independently and with the maps.

The analysis was an iterative process of cross-referencing and code refining. While there are presented results of all three outputs, the richness and nuances mean that some avenues of exploration were beyond the scope of this work due to time constraints.

With this study, I began an exploration of the research questions which are:

1. *To what extent can visual stimuli, combined with quantitative and qualitative methods, contextualise and externalise the cycling experience?*
2. *How can data visualisation support contextual exploration and qualitative expression of active travel?*
3. *What is the relationship between visual stimuli and responses and do the types of stimuli predispose certain types of response?*

I have found that maps are effective in eliciting recollection and engaging people who cycle in reflection of their experience. Thirteen out of fourteen participants, given the choice, engaged with the maps instead of opting for other provided materials (blank paper and drawing tools) and modified the maps themselves. People engaged with a wide variety of maps and no pattern or preference could be detected at this level of analysis. When questioned as to motivation; preference was given for maps with clear names and roads displayed, such as Google, OSM Cycle and Rods, Green areas, Water, Names, and Buildings custom map. However, in some cases, it was explicit that the map type inspired a thinking avenue. Participant Ten stated that the OSM Dark Transport map reminded them of cycling in winter when it gets dark, and Participant Five reflected on the usefulness of knowing the time it takes to

cycle a section of a route based on a map feature (numbers that denoted buses travelling the roads and which were positioned as a label). Further, seven participants discussed bike shops and the need for repair stops, and this was one of the six most frequent themes. It was also a feature in the OSM Cycle map.

The features the participants engaged with the most were the roads themselves (twelve participants mapped a journey). Some icons that were present in maps were referenced and noted in sketches (pint glass, repair shop sign). The five participants who creatively engaged with the maps used icons, pictorials, and marks, as well as created their own symbols to express cycling-related features and experiences.

Looking at the way participants expressed themselves, eight out of thirteen people (60%) made simple augmentations and expressed a lack of drawing confidence. Participants used lines for conveying cycling-specific views and experiences, such as the effort of cycling up the hill or the ability to better engage with the environment while on more leisurely journeys (using a wavy line in contrast to the straight line of the commute).

Regarding the use of colour in their expression. When asked, ten participants claimed that the colours they used were random or a matter of chance and the use was not with meaning. However, the majority of participants did vary colours they used, if not on the same map, then in different renderings. From observing their work in the context of their narrative (recorded interviews), it appeared that changing the colour meant a change of theme and signalled a new subject in their output. This behaviour seems subconscious and automatic. The implication for further research involving sketching outputs is to be cautious when interpreting colour assignments as what looks purposeful classification might be a symptom of the thinking process. Further, the participants who started off with a system abandoned it as the number of endings increased. This might be related to the way we perceive numbers and objects. Particularly, to the phenomenon called **subitising** which is a finding that the human brain can automatically process, recognise and automatically mathematically manipulate small numbers (from 0 to 4) [77]. Subitizing is recognised and taken into consideration when it comes to mathematical education (especially at the primary school level) [102] but I could not find literature on its effects when it comes to organising self-expression in sketches and personal data visualisations.

Looking at what was expressed and how we can see that the expressions can be divided into three categories:

- **Signposting** (general indicators) - bounding that just indicates a locality without further detail.
- **Sorting** - applying texture or colour to indicate classification or hierarchy
- **Detailed** - using icons and symbols to give specific information.

The analysis of the sketches in subsection 3.8.16, and comparison with the maps, have shown a relationship between the level of engagement with maps and the type

of output. Participants with simpler outputs tend to produce sketches containing infrastructure. Without further analysis, it is difficult to speculate as to the cause. It may lie in the contributor's attitude towards cycling and the cycling environment, but there is the possibility that the content of the maps, which were either made for a different purpose or neutral, did not engage the participants in a way that would elicit wider reflection.

When it comes to the type of journeys participants choose to represent, they examined their commute to work/study as the main focus of the exercise. This might be because the study was conducted at their place of employment/study, but only two out of nine female participants included non-employment-related journeys despite the availability of maps at a higher scale, which I presumed would be suitable for an in-depth examination of local areas and to support the exploration of non-employment-related daily migration. Despite the research which has found that women, more than men, engage in trip-chaining [**?**, 280], walk more [36, 264] and do more local travel, [274] these were not included in their outputs. It is not possible to say with absolute certainty to what extent this is due to women's behaviour and to what extent it is related to the map content, but one of the participants made the following comment, which indicates that it is the behaviour and not the map content:

"*Other things, I noticed other maps but I didn't draw on them. Like, the other maps, one was of Oxford Street and stuff like that. And I do cycle along there but not as often. And I have noticed they have a lot of symbols of restaurants and cafes but that is not so much why I go that way and if I am on my bike, I don't think about that kind of thing because I do very much think of my bike as only to and from work really.*"

On the other hand, three out of four male and all (there was only one) non-binary participants explored their leisure cycling as well as commuting to work. This might be closely related to the values and expectations society as a whole imposes on individuals, but it might be reinforced by the maps we produce. Geography and Volunteer graphical information (VGI) are dominated by men and a male perspective [275]. Gardner [116] thesis findings that 87 per cent of the overall contribution to OSM is by male contributors. The contributions differ in type as well, because men tend to concentrate their efforts on accuracy, while women's efforts tend to be directed towards adding new content. The observed behaviours in this study lead me to ask: would the phenomenon of feature-latching and inclusion of content that is part of these journeys encourage women to talk about the more diverse types of journeys? The difference in the type of route choice between genders has been observed [25, 10] and has shown that women choose quieter routes and are more likely to travel further in pursuit of what they perceive as safety. However, the male participants in this study have also discussed routes that are longer but preferred as they are perceived to be safer or more pleasant.

Reflecting on the type of participant the study attracted, there was no uptake from the university support staff and only one undergraduate volunteered. Furthermore, none of the participants had children, which excluded insight into the expe-

riences that are associated with the dynamics of family life.

All of the maps that were favoured by participants had water and green areas, such as the London canal network and parks. These are also areas where cyclists and pedestrians use shared paths. There has been limited research into the dynamics and effects of this practice and the studies conducted in 2016 have found that path sharing can lead to animosity between users [291] and degrade user experience [79]. Clash with pedestrians was one of the most frequent themes and has been mentioned by six participants in eleven instances.

Furthermore, in two of the sessions, one of the themes that emerged was the impact of hidden disabilities, such as diabetes or anxiety, on the route choice and experience of cycling. While it is difficult to establish a figure for the number of hidden disability sufferers in general, Diabetes UK [308] estimates that 1 in 16 people suffer from diabetes.

Looking at the work done, the outputs, and the results of the analysis, the indications are that maps are an effective way to engage cyclists in reflection, as the majority of the people are willing to engage with them and they elicit narrative responses that contain new insights. The features contained in the maps can have a strong influence on the content of the narrative, as we can see in the case of the repair stops, which were one strong cycling feature present in the maps, and which were mentioned by seven participants. Further, the opportunity for the participants to sketch out their routes has led to observations regarding the lack of linking between sections or paths, which was observed by five participants. Also, the lightness of the maps might carry an implication, as Participant Eleven associated the light Google map with summer (drawing ice cream) and Participant Ten associated the dark OSM Transport map with dark winter evenings. Both participants reflected on the impact of seasons on their cycling routines. Temporal change in cycling conditions is present in the literature [154, 213] but seasonality has been less explored, although it seems to be a significant factor.

While most people embraced maps, confidence in their drawing ability seemed to present a considerable barrier [46]. Six participants who were confident when it came to expressing themselves visually, produced maps and sketches with more content. In my next study, I will explore a method that will free participants from the obligation to draw while giving them the advantage of access to the spatial situatedness of a map.

Lastly, it is necessary to recognise the limitations and restraints of this work. Maps are abstractions and approximations of the world and as such bring their creator's biases with them. They are a realisation of intention and materialisation of standpoint. As such, they situate the reader in their virtual landscape. When seeking insight based on maps, it is important to take into account biases that might be present. There are more than two dozen biases identified that affect human behaviour and perceptions. The most relevant to my work is **anchoring bias**, where the starting point (in this instance maps) influences the direction of the narrative [305]. I aimed to minimise the effect it has by providing a wide range of maps that would provide an array of points. However, this exposes another type of bias, **famil-**

iarity bias which is a preference for staying within a comfort zone of what we already know or recognise [305]. My fear was that due to the familiarity bias, all participants would strongly gravitate towards Google Maps as their use is so widespread. This was true in that Google was an entry map (the first to be examined by 50% of the participants) but in the whole of the study, it was not used predominantly or exclusively. In conclusion, while efforts were made to mitigate biases such as anchoring and familiarity bias in the study, it is imperative to acknowledge and address the inherent limitations and influences of maps as subjective representations of reality.

CHAPTER 4

AGENCY AND REFLECTION IN CYCLING - "TAKING MY LIFE IN MY HANDS"

				
Local cycling	Imagination	Family	Social cycling	Utility

Table 4.0.1: This is the image used in the heading for the recruitment poster for the second study. The representations are drawings as I wished to prepare potential participants for the hand-drawn aspect of the study. The images were chosen to convey diversity in cycling use. (Cycling for small errands - far left. Cycling for fun - second image from the left. Cycling with friends and family - the third and fourth images. Utility cycling that is used to accomplish larger tasks - the last image.) Further, care was taken that the persons are of varied ages and the genders are present equally. Lastly, it was important that figures were dressed in everyday clothing, as sports apparel is negatively associated with cyclists [80]and I aimed to attract individuals who cycle, but who do not necessarily identify as cyclists.

The title of the study was chosen because one phrase the participants used most often was: "Taking my life in my hands." This reveals the real sense of danger they feel on the roads but also encapsulates the independence and the sense of power that cycling gives. Qualitative work“Precarious entitlement to public space and utility cycling in Dublin: a grounded theory study” [97] also examines the relations cyclists have with the space around them and the feelings that space elicits. It puts forward a hypothesis that the sense of ownership or entitlement to functioning in public space is eroded by a lack of safety. The phrase “Taking my life in my hands” captures this tension. Barbara Tversky [307] asserts that everything is geographically embodied; emotions, ideas, and concepts. As we travel through the landscape, our likes, dislikes, and associations, become bound to our trajectories.

In this study, I wanted to ask a question:
"Can exposure to unencumbered geographies and specialised vocabulary help reveal aspects of the cycling experience beyond the immediate concerns (such as traffic and infrastructure quality) and reveal what affects continuity, drive and embracing of cycling within a human narrative? "

Maps are ideas of landscape and are both real and unreal. They are abstract reflections capturing aspects of our lives. When we create maps, we can shape and express a view of the world, but this is mostly the privilege of governments and organisations. This project is an experiment in how participatory visualisation can enable individuals to express their experience of topography. By using maps and tokens containing icons, they can represent concepts relating to cycling. In the previous study, chapter 3 participants favoured maps of a lighter hue, with clear street and area names. subsection 3.8.14 In some cases, map colour, or a feature, had a direct influence on the participant's thought process, and we know from the work of Cynthia Brewer [43] that colour choice in maps impacts on how we infer feature hierarchy and patterns in maps, but also that the colour reading is intuitive. Hence, with a variety of maps in different hues, new associations were interesting and welcome, but unpredictable. At the same time, the maps' features, such as icons, proved influential, as implied by the popularity of the bike shop theme. Further, the participants were nervous about drawing and expressed a lack of confidence in their drawing ability. As we can see from the table Tab. section 3.5, eight of fourteen participants did only basic augmentations such as tracing and bounding.

In the first study, participants chose the area of London they wished to work with, which meant that maps varied in their presentation. This was due to some locations having larger green areas, while others were more densely populated. Feature density and visual clutter can cause decreased recognition, with difficulty in segmenting a scene and performing a visual search. [261, 262]

For the second study, I aimed to mitigate these issues and have modified designs in the following ways:

1. **Inconsistencies due to location variation** - all the participants received the same maps, covering one geographical area. The relevance of the maps to the participants was assured by recruiting only people who resided within the chosen locality.

2. **Influence of map hue** - the base maps were neutral colours (grey-scale) and the saturation was used to differentiate the features such as green spaces or waterways.

3. **Relevance of additional features such as icons** - in order to present participants with meaningful prompts, I extracted a vocabulary based on the verbal and visual outputs of Study One.

4. **Drawing ability** - I designed a set of tangible tokens containing symbols based on the vocabulary I extracted.

4.1 Planning the Study

The disruption caused by the COVID-19 pandemic meant that the planned in-person sessions were not possible. Changes, such as social distancing, lack of access to a controlled space (the university), and inability to meet in person, presented real difficulties. I, therefore, decided to explore a digital approach and conduct sessions remotely.

This presented its challenges, and I was aware of the uncertainty, and the logistic demands, as well as the fact that the number of variables I would be able to control had diminished. For example, each participant would need to use their own device. This meant that in addition to differences in adeptness with the tools, there would be technical variations in operating systems and the strength of the internet connection. However, enforced reliance on the devices during COVID-19 isolation periods resulted in the general population's greater proficiency and adaptability in the use of electronic devices.
To test the feasibility of conducting the study, I ran a pilot with three volunteers. The pilot's aim was to test different ways of remote interaction and the planned processes. As no data was collected, there was no requirement for ethics approval.
The original pilot was set using a series of miro-boards. The miro is a cloud-based electronic whiteboard capable of displaying images, text, symbols, icons, and making connections. It is a powerful tool, widely used for brainstorming within teams and for discussion facilitation [182]. The way it works is that users interact with pages that are similar to the meeting room whiteboards [212]. To test its suitability for the study, I created a series of boards, each containing a neutral base map as a background. The volunteers were taught how to insert text, draw, attach sticky notes, and pin symbols onto the maps. Miro allows zooming in, and they could undo their work if they wanted to change it. However, all the volunteers had difficulties locating the areas of interest, achieving precision while interacting with the boards and manipulating extra features. A key point made by all of them was that they found the transition between the zoomed-in section and the overview unsatisfactory at the scale of the laptop screen (13 - 15 inches). The main finding of this pilot was that the tool functions were taking precedence over content creation and I came to the conclusion that the study needed to be redesigned.

4.2 Design of the Second Study

4.2.1 Tokens, Their Design and the Task

As shown by the first pilot, electronic interaction proved to be unsuitable. Due to COVID lockdown conditions, I had to rely on contributors using their own devices. These devices are designed for tasks that require less precision and manipulation than was necessary for easy interaction with the boards. On the other hand, in the first study, a lack of confidence in artistic ability presented itself as a barrier to expression. Participants in the first study expressed reluctance to sketch and they also

used visual components of the maps (such as icons) as a 'seed' for their engagement with the topic and the materials. For that reason, I wanted to remove map iconography which is a vocabulary of the themed maps themselves and provide them with a visual vocabulary that relates to cycling. This probe design aimed to create 'mobile sketches' that would give participants freedom and mobility to express their own journeys in a way that is routed in cycling but spares them from uncovering the basics of the cycling experience elements. It rather provides these in an accessible, mobile, and friendly way that enables them to manipulate, position, and map their own custom experience maps. The round tokens seem to fit the requirement very well. I chose free-standing tokens as they are not attached and participants can manipulate them easily. They can put multiple instances at the locations of their choice and move them if they wish. They are tactile and easy to manoeuvre. Research has shown that the advantages of tangible tokens are that they give clear visual cues, immediate reinforcement and increase motivation [336, 152]

The material tokens were made of paper which meant that they were easy to produce. When deciding on the shape, I took into account that people prefer curved shapes to angular ones and that pleasant shapes produce more brain activity and engagement [59]. Further, circles are more economical and take up less space on the page. The tokens were hand-drawn for a couple of reasons. One reason was to entice the participants to draw themselves by presenting them with an example that is simple and imperfect as the sketches were purposefully rendered naive and inexpert. Another reason was that research has shown that in workshops where participants were exposed to non-expertly rendered images, they showed a greater emotional response and that these types of artefacts promote discussion more than realistic renderings [217, 95, 327].

Hence, I devised a set of tangible tokens based on the vocabulary extracted from the first study and prepared a set of neutral maps covering the geographical area I was recruiting from. The maps, tokens, and drawing materials were packed into A3-size document wallets, which I delivered to each participant's house and collected after the session. All the equipment used (except the token boxes) was made either from bio-degradable or recycled materials. The tokens were cut out and two seven-day pill boxes were used to store them individually. Each participant received 15 tokens for each symbol, plus 15 blank tokens. To help participants identify the tokens, each section containing a token had an example glued to the lid. Further, a laminated list of tokens was included with each of the packs. The token boxes were refilled and re-used. The sessions were run over Zoom and recorded. The limitation of this approach was that I could not see what the participants were doing with the material, hence I implemented a think-aloud method [156] where participants were asked to describe their actions and reasoning.

During the Zoom session participants were invited to explore the content, although all of them did so before the session started. Nevertheless, I introduced all the items and invited them to take a few minutes to explore the legend of tokens as well as look at what else they had. Next, they were asked to **use the provided materials to express their cycling experience**. When they asked for clarification, I asked them: "What would you like people to know? What matters to you? This is your



Figure 4.2.1: Each participant, study two, received a pack like this containing maps, blank paper, coloured pens, a pencil, glue, and cut-out tokens. The token box in the image is only an example.

id

chance to tell your cycling story." I explained that they could use all the materials provided and asked them to refrain from writing. Lastly, I asked each participant to use one of the blank tokens and make a token for rule-breaking. My aim here was to start them off sketching by providing them with an excuse to explore how would they go about it. This was under the pretence that I had forgotten to make one of the tokens and would they be so kind as to create it for me?

Similar props are often used for ideation [72, 126, 190] and as support in a design process by the HCID community. For instance, as a part of their work that explores challenges in end-user system development Booth and Stupmf[35] devised an image and text card system that supports problem-solving and facilitates creativity. Huran et al. [152] use tangible tokens to explore the accessibility of visualisations with a non-expert audience. In the work on collaborative planning [148] tangible tokens are a part of the toolbox used for the design process. Card Mapper goes a step further [72] and uses card-use data to build visualization based on the connectedness of ideas and strengths of concepts.

When designing the tokens, I drew inspiration from the first study outputs. This gave me the basis for the content of the tokens. Also, in drawing the tokens, I replicated the icons and pictorials from the first study as much as possible. To make the process more approachable, the tokens were hand-drawn [327]. The drawings are deliberately imprecise, despite their content being chosen deliberately and with



Figure 4.2.2: Thirty-nine tokens were given to participants in the second study, along with the base maps and drawing materials.

care. The aim is to reassure contributors that aesthetic perfection is not the goal and to ensure, as much as possible, that drawing skill is not a barrier to engagement (with blank tokens or base maps augmentation). In addition to the pre-made tokens, each participant received drawing materials and several blank tokens they could draw themselves. Examination of the first study outputs and the analysis has resulted in a choice of 39 images. These fell into four categories:

- **Surroundings** - wind, trees, graffiti, environment, shop, nature, pollution, noise, construction, music, weather
- **Infrastructure, infrastructure actors and motorized transport** - bus, up/downhill, potholes, traffic light, bike repair, has signs, cars, good/no parking, infrastructure, barrier, break in flow.
- **Abstract terms that are implicit in the interaction with space.** - joy, confusion, barrier, memory, break in flow, thinking, alert, safety, independence
- **Interaction with society**- overtaking, gender clash, other cyclists, pedestrians, people.

Some tokens were considered to belong to more than one category as they can be physical or mental. These are a barrier and a break in the flow. The set of tokens representing concrete terms were easy to represent as the terms lent themselves to tokenization and spatial placement. 60% of the tokens were a direct transfer from the first study. However, the second set presented a challenge due to their intangible nature. There is no question as to the importance of these factors but their elusiveness and non-physical character made their capture and representation less straightforward. After a couple of design iterations and discussions with my supervisor, the collection of 39 tokens was finalised Figure 4.2.2. The tokens were labelled for clarity purposes.

4.2.2 MAP DESIGN

In contrast to the previous study, in which participants were not from the same area of London, and had their own set of maps covering locations of their choice, the participants in the second study were recruited within boundaries of two adjacent London boroughs and were provided with the same materials. These were 15 A3 size maps that could be combined into a larger map, should a participant wish to. The map design has been addressed in the section chapter 4. The maps were at the scale 1 to 200 metres, as this provides both detail (individual street names can be read) and overview (it would take roughly 10-15min to cycle from from top to bottom of each map). Also, maps needed to work with tokens, which were 2.5cm in diameter. Smaller token sizes would have made it difficult for participants to create their own, and thus affected the range of topics they would have been likely to express. The largest size of paper at my disposal was A3, which is 29.2cm x40.00cm. If the scale was smaller, tokens would have been too large for the map. Maps were created using mapbox map building software and monochrome light template [197].

Wishing to make the boundaries of the visualizations less rigid and definitive, I drew inspiration from the work of Johanna Drucker [94] where she argues that innovative and engaging visualization can communicate complex and less tangible ideas studied in humanities. For that purpose, at the outset, I considered augmenting maps in a way that would imply depth and transcend the two-dimensionality of printed maps. The design I settled on was the inclusion of a shadow that would be a literal symbol of depth and act as a reminder that the map space is something they are in, leaving the rest of the page open to augmentation and correction.// While the idea worked well as a sketch and on the screen, it did not work in the print as the inclusion of the shadow would have shrunk the maps too much. As mentioned, maps had to be on a scale of 1:200m scale as this provided sufficient detail and overview. Hence that design was not implemented with the participants.

4.3 Dr. Bike Collaboration

The right approach for the first study recruitment was *recruitment of convenience*, and the response was satisfactory, despite the fact that the call coincided with industrial action. However, the demographic makeup of the sample was uniform and failed to capture economic and stage-of-life diversity as all the participants held Glossarywhite-collar jobs or were students in higher education and had no families beyond a live-in partner. A different approach was needed to open up the pool.

Hence, the recruitment for the second study was different, in that a more strategic approach was planned which aimed to maximise the chances of attracting a wider socio-economic group.

I have been cycling in London for the last ten years, and since starting my studies, I have become involved in cycling advocacy and cycling outreach. Both, as an individual and in advocacy, I have observed that the cycle-maintenance scheme known as Dr. Bike has contact with a wide range of people who cycle. The scheme is popular, open, widespread, and well-known. It is run at a variety of accessible locations such as parks, public institutions (like schools and hospitals) and community events. It is extensively used by people who own bikes regardless of cycling proficiency, age, or ethnicity. For those reasons, recruitment through the Dr Bike network and in parallel with their sessions was considered an appropriate strategy.

Due to the pandemic restrictions, the operation of Dr Bike were modified and the involvement of external individuals was restricted. For some time, no one could run additional activities alongside Dr Bikes' sessions as they had to adhere to strict social distancing rules. I contacted the organisers by email and they agreed to promote the project by displaying the recruiting poster and making the leaflets available to people who use their services. The material they distributed (poster Figure 4.3.1 and flyers) had wording and design which aimed to be inclusive and inviting, without constraining or pre-disposing participants. The images on the poster were bound to social and utility aspects of cycling and not the image of a cyclist as a sportsperson, which has negative connotations [80]. The aim was to engage the people who cycle



Figure 4.3.1: This is the design for the recruitment poster and the leaflets for the second study. The document features a brief description of the study, a selection of drawings that relate to cycling, and a QR code that, once scanned, leads to the expression of interest survey.

but do not consider themselves as *cyclists*, due to the shortcomings of that definition and not due to their lack of cycling proficiency.

The images on the promotional material show different aspects of cycling and are meant to prepare volunteers for interaction with the tokens which contain concepts that are not necessarily bound by geography but are connected with cycling.

Also, they were meant as an invitation to all people who cycle regardless of the objective. While recognising the reality that interpretation is subjective, loosely, the concepts are Figure 4.3.1:

- Social cycling - cycling in the company for the purpose of sharing a mutual experience.
- Fun in cycling - cycling for pleasure and enjoyment. It includes finding self-expression through cycling.
- Family and cycling - cycling with a family either for utility (school drop-offs and other types of family commuting) or for leisure.
- Utility cycling - cycling for utility purposes. This can equally be doing family shopping or cycling as a tradesman.

The thread of exposing participants to drawings relating to riding a bicycle that is beyond the traditional type of images and cycling representation continued throughout the process. I illustrated the surveys with playful asides in the form of sketch miniatures. These images were:

- Cycling cat-superhero 
- A sketch of an old-fashioned horn. 

These images differ from the first set and aim to leave participants with a better idea of open boundaries.

4.4 Recording of the process

Due to volatile and unexpected circumstances that were the consequence of the COVID-19 pandemic, the study was planned in a way that could be run despite the possible, remotely. This imposed certain limitations on the way the process was recorded and documented. The visual observation was limited by the size of the screens and the position of the camera. To compensate, a think-aloud approach [2] was adopted that is widely used in Human Computer Interaction (HCI) studies [60, 159]. In the think-aloud, participants narrate their actions and the thinking process. As the visual component is crucial to my work, the participants have been asked to take photographs at the significant points, or if there is a change in thinking. To assist with the analysis, the participants have been provided with numbers to place inside the image and to articulate the actions. The design of numbers was

carefully considered as they should not interfere with the process and be distinct in appearance from tokens. Hence, the colour scheme chosen for the numbers is bright and differs from the colour scheme of the map and tokens.

4.5 The Recruitment and the Implementation of the Workshops

As per the approved (Ref number: ETH2122-0250) workshop plan and proposal Appendix subsection .2.1subsection .2.2, the recruitment for the sessions was done by attending Dr. Bike sessions in the boroughs of Walthamstow and Hackney. The two boroughs were chosen as they are local to where I reside and would make dropping off and collecting materials manageable as well they were within the government-approved travelling distance (a limit on travelling distance was imposed as one of the COVID-19 containment measures in the UK). The reduced number of Dr. Bike sessions and the limitations on interaction made under-recruiting a reality. To mitigate this, a part of the recruiting was done by advertising on a neighbourhood discussion and exchange platform Next Door.

Over the two months, I had fifty-five responses of interest. Out of the fifty-five, fourteen applicants completed the study; there were eleven female and four male participants. The study was opened to everyone over the age of 18 who lives in the two neighbouring boroughs of Hackney and Waltham Forest and who cycles. The initial survey screened out everyone who was under 18 and those who couldn't take part in an online meeting. I accepted everyone who lives in the two boroughs I was recruiting from, cycles and fits the two aforementioned criteria. There were no set and separate recruiting and implementation periods. All the stages were run simultaneously and the finalisation of recruiting was decided based on the time allocated for the study. Out of fourteen sessions, the data from two participants' was not included in the token-map analysis as the materials either did not make it back to me or were corrupted. As with the first study, the gender representation was disproportionate as the majority of participants were female. The participants filled in the demographic survey questions, which were a part of the expression of interest and the consent forms Appendix. subsection .2.3. This gave me some insight into their cycling experience, the type of cycling they do, and whether my efforts to create a study with a diverse cohort were successful. I asked participants what type of cycling they do and gave them a choice of *daily cycling, commuting, cycling for leisure, occasional cycling, and competitive cycling*. Multi-choice was possible for this question and ten participants chose two or more options. Commuting was the most popular form of cycling with 9 participants, and leisure was close behind with 7. Only one participant was a sport cyclist Tab. Table 4.5.1. All the participants were experienced cyclists with eight cycling for over forty years and four participants cycling between ten and twenty years.

To enable participants to express their race and ethnicity, I gave them eight options, a chance to withdraw from expressing their ethnicity, and a tab for self-identification.

Self-expressed frequency and type of cycling	
Commuting	10
Leisure cycling	7
Daily cycling	5
Occasional cycling	4
Cycling as a sport	1

Single or combined forms of cycling	
Combined forms of cycling	10
Expressed a single form	4

Table 4.5.1: Participants expressed which type of cycling they engage with. The most common answer was commuting, followed by leisure and daily cycling. Ten participants considered themselves the type of cyclists who engage in different forms of cycling.

.....Ethnicity of participants.....	
British	7
European	3
Mixed origin	2
Black	1
Rather not say	1

Table 4.5.2: Most of the participants in study two self-identified as British, with three identifying as European, two as mixed origin, and one who did not wish to say.

The proportion of cycling done with children	
Some	7
None	6
Most	1

Table 4.5.3: Half of the participants in the study two cycle with children to some extent, while the other half do no cycling with children. One participant cycles with children most of the time.

The majority of the participants identified as British (7), with three identifying as Europeans, two of mixed origin, and one person who did not wish to express their ethnicity Tab.**??**.

The next category I wish to discuss here is the proportion of cycling done with children. Half the participants cycle in the company of children at least some of the time, while most of the other half never do. One participant does most of their cycling with children Tab. Table 4.5.3.

Thus, to some extent, I have been successful in diversifying the cohort. There is a better representation of family cycling, with half the participants doing some of their cycling with children, and some ethnic diversity as two contributors identified as mixed race and two as belonging to ethnic minorities.

Lastly, the applicants provided their profession. While the first study consisted of mostly administrative and academic staff, participants in the second study were more diverse and more economically stratified. Six participants had employment in white-collar jobs (teachers, GP, software development), there were three artists, one mechanic, one youth worker, and one self-employed individual.

4.6 Analysis

The first study was analysed by use of thematic analysis that relies on the frequency of terms and ignores the context, the speaker's inflexion, or the importance they put on a certain term. The themes I found were disjointed and told a story that jumped from one aspect to another without much connection. In the discussion for the first study Section section 3.10, I mentioned some less recurrent themes such as the relationship of cycling with hidden disabilities and mental health, but other subjects that participants talked about were lost (such as getting to know the city by bike as a form of tourism, the effect of moving a house on the safe route access, and the impact of disruption in the form of needing to make mental adjustments while dealing with the demands of traffic, to name but a few). By ignoring the context and inflexion, we lost terms that were on the margins. These might be the less-discussed terms in cycling promotion and research, and participants are not used to hearing or discussing them. Research on surveys has identified social desirability as a contributing factor in shaping people's responses in public consultations [172]. My second study explores maps and tangible tokens as vehicles for personal narration, which contextualizes the themes and reveals tensions that might otherwise be missed.

I argue that each journey we make has a form that resembles the structural narrative analysis, as pioneered by Labov [175] Figure 4.7.1, in that it is sequential, has its complications, resolutions, and conclusion (coda). Each journey is a mini-story that fits in the person's other stories, and the larger narrative of their cycling. If we ignore this positioning, we are omitting aspects of cycling that are influential to human reality and the practice of cycling.

The following section contains a justification for the narrative approach to analysis and its introduction. The analysis will try to answer the following questions:

- How do people structure their expression when it is supported by spatial stimuli and tangible prompts?
- What individual narratives we can discover?
- Do the individual narratives create a cohesive general narrative?

4.7 Narrative analysis

Qualitative analysis has a lot to offer to the field of data visualization and has been used in projects ranging from exploring the development of visualizations in primary educational settings [32] to sketching personal data [317]. The field of data visualization has started to recognize the value of experience and the need for reconciling the qualitative aspects of human lenses with the quantitative nature of data presentation. We can see examples from introducing specific qualitative techniques [145] to proposing new criteria for evaluating design outputs and processes based on interpretivism [209].

Data is rigid, a snapshot in a continuum, a point on a trajectory. Hence, I argue that work in the dynamic arena of examining people's relationship with the ever-changing urban environment, and a person's place in it, could benefit from an approach with plasticity, something that would give us several points and fit a curve of people's lives. The usual approach is to conduct longitudinal studies that employ continual, or repeated measures over long periods of time, sometimes decades [48]. Longitudinal studies require a long-term commitment and significant resources. This makes them impractical and not feasible as researchers often lack the financial and time resources necessary. In this study, I wanted to examine the possibility of coming at the problem of temporal evolution from a different angle. To use maps and tangible tokens to elicit stories from participants' lives that capture their cycling experience in a way that would inform us of pivotal moments in their cycling evolution - not just snapshots of a single point.

Narrative analysis is a case-centred qualitative analysis method, that helps the interpretation of the text, or visual data that expresses narratives. It gives insight into lived experience [41]. In contrast to methods like thematic analysis and Interpretative Phenomenological Analysis (IPA), which cut across the data to answer the question of *what* is prevalent, the narrative analysis aims to answer both *what* and *how* in a holistic way that preserves the integrity of an individual. It achieves that by placing the *what* in the surrounding context of the long experience and preserving continuity [41]. There is no prescriptive structure for performing narrative analysis but there are different approaches within the narrative research community [257]. The approaches are not mutually exclusive and have no hard boundaries. Some of the criticism of the narrative analysis is that individuals do not express personal points of view but tend to integrate their account with the wider organization or a community they associate with. Also, the positioning of narrative by assigning a class to it such as gender, age, or socio-economic group, is a reductionist way of looking at the human experience as we all have multiple narratives [285]. A further point we need to consider is that people narrate stories which reinforce their political affiliation or a group narrative they associate with [255].

This is particularly relevant as the participants in this study have a commonality, in that they belong to a transportation subgroup of cyclists. In the expression of interest survey section .4 thirteen out of fourteen participants stated that cycling has some degree of importance to their self-identity, despite the majority stating that they are not a "cyclist". However, I hypothesise that the combination of maps and tokens will be sufficient in aiding the individuals to focus on their own experiences and be less reliant on the learned group narrative. This, in turn, will help identify new aspects and viewpoints regarding cycling, and broaden the discourse regarding cycling in cities.

There are several approaches to narrative analysis. **Structural narrative analysis** focuses on the form and how the story is told. [257]. First developed by William Labov [175] its focus is on the examination of the narrative devices and the way the subjects communicate. It proposes that all stories have a *narrative structure* they follow Figure 4.7.1 and that consists of:

- Abstract - this is an introduction to the narrative and serves to set the scene;
- Orientation - places the story in time and geography;
- Complication - is the active part of the story or the plot;
- Evaluation - where the narrator reflects on the story, evaluates it and its impact;
- Resolution - is the section where the narrator looks for a solution and moves away from the story;
- Coda - ending and exiting the story.

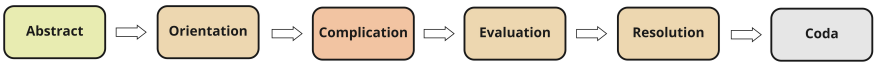


Figure 4.7.1: The narrative components as proposed by William Labov [175]. The narrative is sequential and has temporal progression. It starts with the abstract(introduction), progresses through orientation (place and actors), complication (problem statement), evaluation (meaning and emotion), to resolution (the outcome or conclusion), and coda (returning to present)

Not all of the above components are always present or in chronological order.

Interaction analysis emphasises the dynamic between the subject and researcher as co-constructors of narrative. The best results are achieved with the inclusion of paralinguistic features such as pauses, transitions, and topic chaining.

Performative analysis, as the name tells us, looks at how the study is enacted. It is appropriate for studies of communication practices [257] as it lets us examine where tellers set their story, which actors they introduce, and how they relate to the listener, as well as their audience.

Thematic narrative analysis emphasises the content over structure. In this case, the analysis inductively uncovers thematic topology in the narratives and groups them by concepts. The thematic approach is particularly useful for determining the group narratives and thematic tendencies of a cohort.

4.8 The Place of Narrative in Visualisation

To some degree, all data visualizations are narrative. They uncover stories and expose relationships. The users of visualization for analytic purposes are akin to explorers, uncovering the tale.

Narrative in data visualization refers to the way that a story is conveyed through the visual presentation of data. There has been considerable research in recent years on the use of narrative techniques in data visualization, which is used to make complex data more accessible and understandable to a wider audience [164].

In 'Telling Stories With Data', Siegel and Heer discuss techniques for storytelling in visualization and present an analysis of techniques and visualization devices for visual storytelling [271], while Hullman looked at how the visualization incorporates structures[105], the framing of narrative by visual devices [150] and what is the role of sequence in narrative visualization [151]

Kosara examined how narrative fits in the context of data visualization [120] and incorporating narrative into data visualization through the use of visual metaphors. He explores the relationship between spoken and visual metaphors and how they influence cognition and interpretation [339].

Liem, Perin, and Wood take a different approach and investigate the impact data visualization has on the reader and their attitudes [185] by looking at the relationship between story-induced empathy and the change in attitude. In this study, I look at visualization differently. not at visual creation but the ability of geographic representations to evoke and support story creation. How the spatial situating, by use of maps, combined with topic-related prompts and expression opportunities (control over the distribution of tokens, freedom to augment, sketch, and contribute) enables expression of narrative that encapsulates personal cycling experience. In support of this approach, I should also mention the theory of triangulation [82] which proposes that to understand and uncover the narrative we require multiple external sources of information, each contributing to the shape of the story.

4.8.1 NVIVO

NVivo is a tool [140, 183] which is widely used in academia for the qualitative analysis as well as qualitative aspect of mixed-methods approach [15, 283]. However, like any tool, it is dependent on the application and has its limitations [332].

Following the academic examples and the recommendations, NVivo was an obvious choice of analysis-enabling software as it is suitable for a variety of qualitative approaches and supports a diverse ecology of file types. This is convenient for studies, such as this one, that collect a mixture of outputs. It enables all materials to be consolidated in one location so that the same coding schema to be applied to them.

Using NVivo requires a certain level of training and preparation. While it was not possible to acquire advanced expertise, I was able to reach more than sufficient proficiency to effectively use it for my projects.

However, I did not use the software extensively, as despite the NVivo accepting images, working with large maps, which contain high concentrations of information, proved to be too fractured and unwieldy.

NVivo was trialed in the first and second studies and in both instances, the software use was partial or abandoned in favor of working directly with maps and physical coding. The screen real estate devoted to the presentation of images is approximately a quarter of the overall screen size and of poor resolution. To distinguish the input instances, one has to zoom in and this loses the overall context. Furthermore, all the nodes are displayed at the same time, regardless of their class, and coding rich

outputs of a study with a small sample lead to a high volume of nodes and loss of organized overview. Hence, using physical maps with the combination of Excel tabs and text provided better access and overview of different aspects of this research.

4.9 PARTICIPANTS

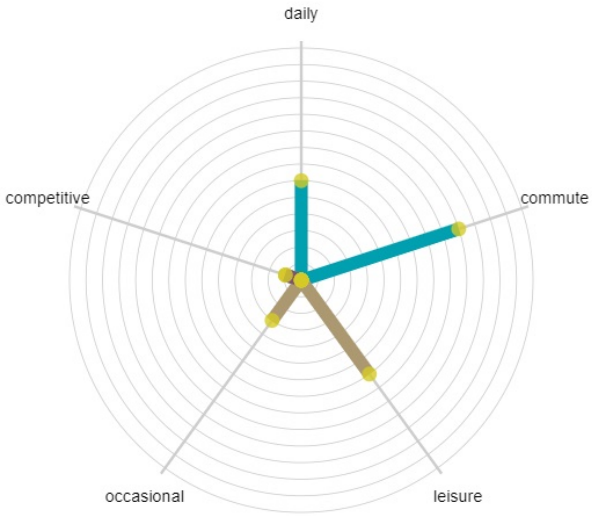


Figure 4.9.1: Most of the participants cycle daily and ten use bicycles for commuting. Eight participants stated that they use cycling for leisure, while only one participant does competitive cycling.

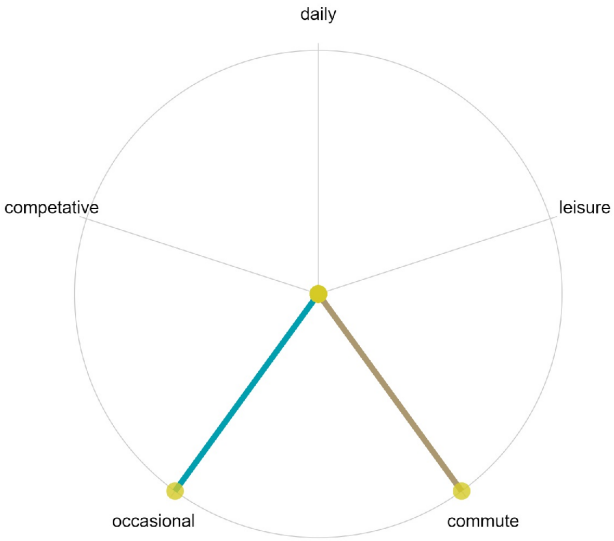
Cycling class	Survey option
Cycling often	Commute
	Daily
Cycling sometimes	Leisure
	Occasional
Sport cycling	Competitive cycling

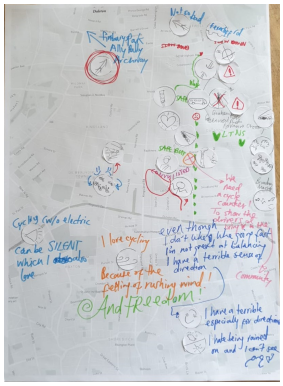
Table 4.9.1: Each participant had a visual stamp of their self-expressed cycling habits. Participants were given six options, which were divided into three classes depending on frequency and purpose.

Each participant was treated holistically and their story was examined. It would be unpractical, and not informative, to present all the narratives in the main text of the thesis, so for illustration purposes, I am including four examples. The remainder can be found at section .3.In the analysis text, I will enclose the name of the token within curly brackets and mark it in *italics* to indicate the tokens chosen by the participant to support that section of their narrative. Also, I am including examples and quotes from the interview, which will be in quotation marks and italics. Each participant section will have a heading that contains a visual 'stamp' of the self-identified cycling habits of the said participant and a representative example of their interaction with the material. Cycling is classified by frequency and intent as often, sometimes, and sports cycling, Tab. Table 4.9.1. As can be seen in Figure 4.9.1 most of the participants cycle often, with commuting being the most popular journey (ten answers), followed by leisure cycling (eight) and daily cycling (6). Only one

participant takes part in competitive cycling. The frequency with which people cycle for leisure can vary widely depending on several factors. A study conducted in the United Kingdom by Sport England found that in 2019 2.4 million adults cycled for leisure at least twice a month [288]. The COVID restrictions and the shift this brought changed people's habits but this thesis is not looking at the COVID impact, hence leisure cycling is classed as intermittent. Competitive cycling is in a class of its own.

4.9.1 PARTICIPANT ONE: P1





P1's visual persona | P1's mapping

Table 4.9.2: Visual stamp of self-identified cycling activity and an example of output the participant has created.

- **Gender:**Female
- **Profession :** Artist and bookbinder
- **Age :** 30-50
- **Ethnicity:** Rather not say
- **Importance of cycling for self-expression :** Slightly

Abstract: P1 expressed doubt as to whether she would qualify for the study as she does not see herself as a *cyclist*. This is despite cycling often and making a financial investment to buy a *Dutch bike*. Dutch bikes are a special, sturdy and expensive, type of bike that is very suitable for carrying cargo and children. P1 has two children, one at primary school and the other at secondary school. Most of P1's bicycle trips are local, partly due to the fact that she, and her husband, are independent publishers and work from home. The Dutch bike is used instead of a car for carrying children, shopping and books. This is in spite of the fact that they are a household that could have a car as the adults are both holders of a drivers' licence. However, the whole family cycles and her older child cycles to school independently. She has told her story in four maps, which she did not combine in a large single map, but which

are still bound together in a single narrative. As an artist, her expression was quite sophisticated and she used all the material at her disposal with ease and effectively.

Introduction

"*Oh man, I am such a non-cyclist I will only do maps near us. Oh, man. It's so lame, I can't even cycle to Leyton.* "

This participant introduced the narrative verbally, without the use of the maps, as she wanted to distance herself from what she thinks cyclists are, and to set the scene as to her cycling outlook and tolerances. She stated that she cycles only locally and in places that are not demanding by being crowded and polluted.

She explained that she does not feel safe in places where the environment is neglected, as she fears being mugged, and that she forms strong associations with geographical regions. This influences her decision whether she will cycle somewhere or not. Once the impression is made, it is persistent.

"*I wouldn't cycle there as I consider it messy and wee covered. Mind you, I haven't been there in twenty years and it might have changed and it is lovely now but that is why I wouldn't go there.*"

She started the interview by stating that she would talk about the 'school-run' cycle, but once she looked at the map, that narrative was abandoned.

Conflict - "The story of growing up-map one

"*So, one of the things, when we go south, is cross Dalston Lane. Crossing Dalston Lane and Graham Road but really, you can't find a way of crossing either of those things.* ".

She opened with the particular issue that she has identified, and that was the difficulty in crossing busy roads Figure 4.9.3.

The issue has presented itself since her older child started attending secondary school and began cycling to a new destination independently. The map is narrated in terms of how the borough has facilitated this change in her family's travel patterns. In order to communicate her view of the severity, she used *red colour* to draw a token *danger*, which she put twice and combined with *break-in-flow, no signage, bus and no infrastructure.*

The main complication is the cotrast between these crossings and the remained of the route, which has positive associations (*infrastructure, nature, and music* and Low Traffic Neighbourhoods (LTNs)). This break in flow has an impact on the journey which she described and supported with a verbal elaboration. The perceived threat to the safety of the teen resulted in a new, convoluted, route, where even adults get lost when accompanying the child to their school.

While telling the story, she also reflects on the more general considerations, like interaction with other cyclists and Low Traffic Neighbourhood (LTN)s. Regarding the other cyclists, she has expressed the same sentiment as the previous participant. She sees other cyclists as both good and bad in that it is good to see people cycle, but other cyclists can sometimes seem aggressive and she feels vulnerable on a slow bike carrying children. LTNs she has marked with green and sees them as areas of

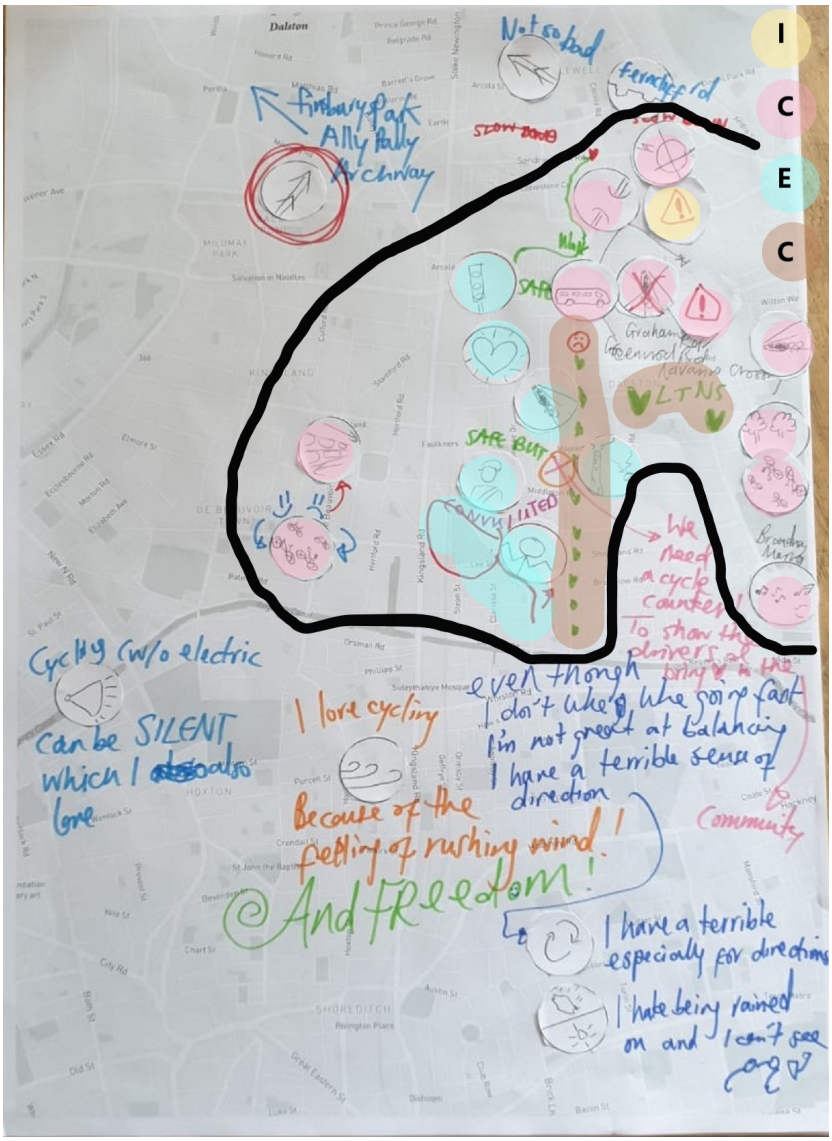


Figure 4.9.2: The black outline frames the section of the map that P1 has used to express the main complication in her cycling. The tokens in the bounded area are highlighted by the role they had in the mini-narrative of the issue. The *yellow* is I- introduction, *pink* marks the outline of the problem C-complication. The *blue* is the E-evolution and resolution, taking the steps to mitigate the issue and the *brown* is the conclusion/coda (C- coda) that brings the narrative back to the present.



Figure 4.9.3: [P1- Study 2] Participant One used the colour (red), created tokens, drew on the map and grouped tokens in order to communicate the severity of the issue.

safety.

She resolves the issue of the new, convoluted route in a similar way to P2, by exploration. In this case, she repeatedly gets lost and learns the environment by trial-and-error, eventually becoming familiar with every eventuality.

She points out a section of the route that contains cycle infrastructure and marks it with *green hearts*. This leads to a reflection on the trade-off between the pollution that is present and safety. While willing to make the said trade-off, the cycle infrastructure is not sufficient to ensure her child's safety as it does not reach the destinations on either end.

The conclusion was a contrast between the impossibility of being safe at the junction due to riding a bike with a passenger and the joy of entering the LTNs and safety. She considers the junctions especially challenging for types of bikes that are not 'traditional' single-user commuter bikes, i.e. bikes with child seats, bikes with trailers, cargo bikes, and bikes ridden by novice riders.

" *"If I am on my own, I am all right, if they are on their own, they could easily make a terrible decision at that point."* **Evaluation - "The story of connection"- maps two, three** and four

"*...these junctions, that I am surrounded with, dictate which direction I go.* "

In Labov's model for narrative analysis [189], *evaluation* gives the reason the story is being told and contextualises it. In maps two, three and four the participant illustrates the importance of the themes raised in the *map one- story one*. She does this by discussing three journeys her family makes. The first is the journey to Victoria Park. The focus of her discussion is not the destination but the section of the journey that goes through London Fields park. The park was mentioned during the previous narrative as a place of safety and joy, and its inclusion seems important. London Fields is a popular local park [62] with a wide range of amenities, e.g. playgrounds, a lido, and sports pitches. It is also the junction of two cycle routes and its main thoroughfare is divided into a section for cyclists and one for pedestrians. The participant talked about London Fields as a haven from traffic, but pointed out some issues. The pedestrian and cycle sections are marked with paint and there is no physical divider, which, P1 observed, has resulted in *rule-breaking* and spillage of pedestrian traffic into the cycle lane. Further, she feels more vulnerable to crime in the parks than when cycling on adjacent roads.

The focal point of the narrative was a contrast between the crossing of Graham Road where there is *overtaking* by fast vehicles, *pollution* , with the changes made at the other end of the park.

"*Closing off the Richmond Road at the top of London Fields has made cycling to Victoria Park wonderful and I have actually written to Hackney Council thanking them.*"

From that point, the participant explicitly talked about junction improvements which had a transformative effect on her family's mobility.

The **map three** was devoted to the swimming lessons journey, which was made



Figure 4.9.4: P1 the second map augmentation.

possible by a new junction on the route between the participant's residence and the leisure centre, while the **map four** is used to show an improvement that made a journey to a specialised library possible. The two maps were done in quick succession and have identical marking.

"*I would never consider going to X any other way except with bikes now. I didn't know when they made those junctions they will make so much difference.*"

Resolution and Coda - "Change of direction" - revisiting maps one and three

"*Now, going North, is always a struggle, no matter what infrastructure is in place as I have a great, big, heavy bike. It's OK if I am on my own but it is not good for going with children*"

For the last part of her story, this participant re-visited the maps one and three. She briefly addressed cycling in a different direction and accessibility of northward areas. However, she finds the geography in that direction hilly and very challenging to negotiate with her bike and the children.

The topic she wished to discuss was cycling across bridges (*map four*). The recent inclusion of segregated cycling paths on some bridges has made journeys across the river accessible for her and her children. The act of crossing the bridge is an event that gives pleasure due to the scenic views that can be seen. A combination of *nature* and *built environment* , seen from safety brings her *joy* in that it stimulates her senses and she feels protected.

From there, the narrative evolved into general reflections on cycling (*coda*). She combined writing and tokens in an essay on her love of cycling. She wrote about things that she likes, like the *wind* in her hair, freedom, absence of *matter* and a sense of belonging. She reflected on the reasons why she shouldn't love it too; bad *memory*,lack of sense of direction and not being able to see in the rainy *weather*.

She concluded with the observation that bad junctions discriminate against children and less able cyclists, and that safety takes precedence over expedience, and taking a longer but pleasanter and safer route is easy for cyclists to do.

The unexpected actor

As well as narrative sequence, stories have settings and actors. In this participant's story, these are her family, the junctions and her bike.

The tokens participants were presented with were made to address material environment(infrastructure, parking, trees), the interactions (pedestrians, other cyclists, overtaking, music) and internal effects of cycling (joy, memory, alert). However, the bicycle itself was not included and was considered to be a 'silent partner'. In most cases that is true, and in Study One only one participant talked about their bicycle. However, for this participant, the bicycle they own is a family vehicle and not an individual's transport. It is a Dutch bike, produced for the environment, that is adapted to a wide range of cycling needs. In London, a Dutch bike is useful but ungainly. Due to its size it demands more space than the city is able to give it, and the participant is acutely aware of this.

"*So, with my bike, which is a big Dutch bike, and its very heavy....great, big heavy*

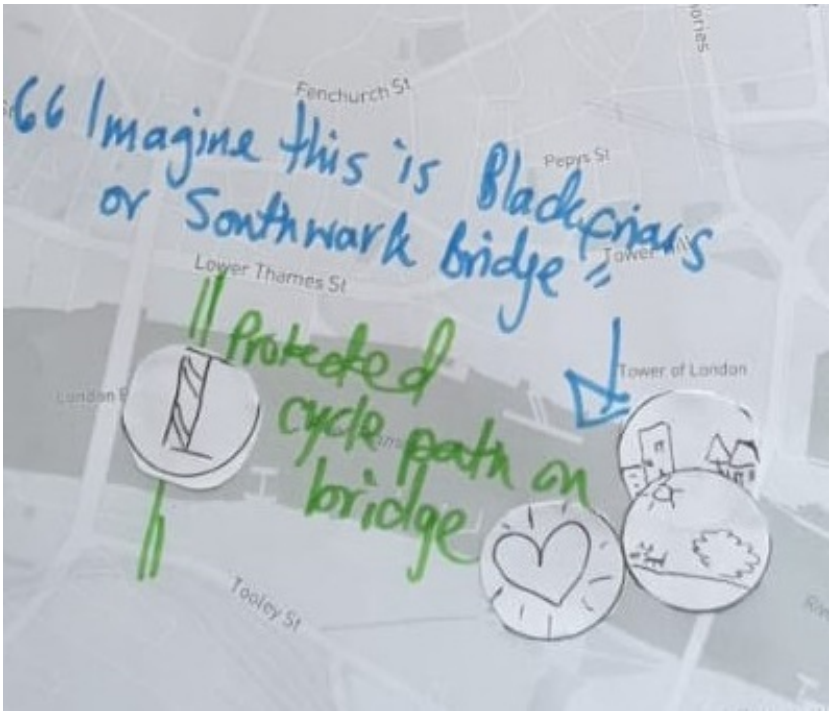


Figure 4.9.5: [P1- Study 2] This bridge augmentation generalises Participant One's thoughts on bridge crossing. She uses a mapped bridge to discuss bridge crossing in general and a bridge that is not present on any of the maps she was given.

bike...and I have this big bike loaded with books and children."

The bike is an entity that is mentioned and described in all parts of the narrative. It is usually given the attributes 'heavy' and 'big', but is applauded for its functionality, and is highly valued.

" *"I can now carry 20 -24 books back each time and a child...I couldn't be bothered with play-dates as it was so difficult to pick them up but now I got the big bike, I just swoop by and collect the child in no time."*

However, the rider seems to be constantly aware of its dimensions and the different type of riding that is required.

"*I will be very slow on bike. I don't like going fast. Anyway, I have a great, big, Dutch cargo bike usually with one or two children and lots of stuff.*"

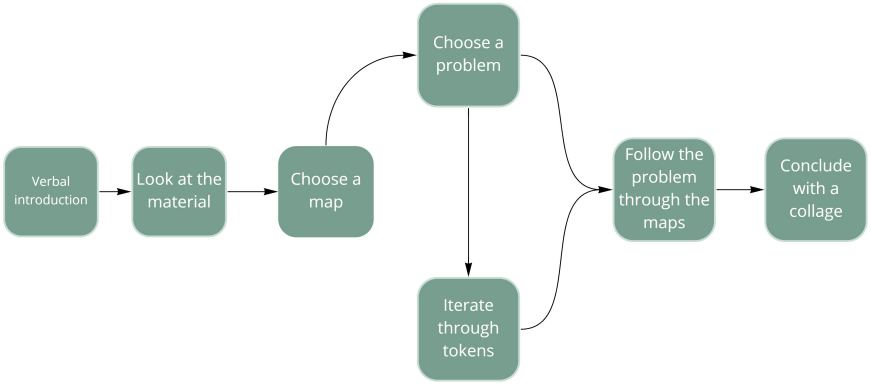


Figure 4.9.6: [P1- Study 2]The flow of actions for Participant One.

Structure of the expression This participant included a number of anecdotes and one had an impression that with banter, they were making fun of distressing experiences in order to lighten their impact. As an example, she described a severe reaction to effort and a hostile cycling environment as an amusing anecdote (she lay on the floor of a busy street in London as was spent physically and emotionally).

While the participant's main focus might be seen as infrastructure, the narrative gives this a context. We see that the experience of the infrastructure and the relationship with the space around them changes as the family evolves through its stages (children riding independently, children attending a new school, family purchasing a new type of vehicle).

The beginning of her narrative was map-led and map features acted as triggers for starting her story. This was evident due to the participant starting to talk about one journey (the school run) but after looking at the map, taking a different narrative direction (difficulties crossing junctions). The shift might be due to the recency bias which describes people's tendency to discuss more recent events [113]. Hence, the first topic she reached for was the most recent journey she completed - the school run. However, the maps and tokens opened up other possibilities and the school

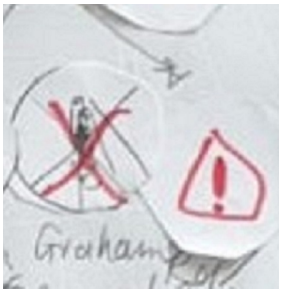
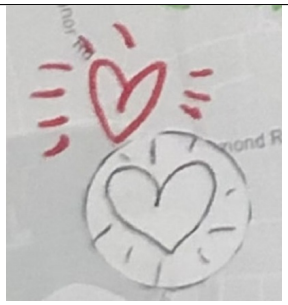
		
Red - negative	Red - positive	Blue - positive

Table 4.9.3: [P1- Study 2]In the first two images, we can see an example of colour inconsistency across the maps. Participant One used the same hue to represent opposites in two maps (the use of red for danger and the use of red for joy). In the second and third images, we can see emphasis (token heart and drawn heart) but the use of colour is not consistent.

run was not mentioned during the rest of the session.

This participant seems to be a very visual person and sophisticated in their expression. She used colour, even in writing Table 4.9.4, and used all the visual channels at her disposal. In the table Table 4.9.5 we can see an example of how this participant refined their output. In all four examples, she discussed the same phenomena. The example from the first map has the tokens (*traffic light, joy, infrastructure)* freely placed onto the map. In the second example, the traffic light and the infrastructure are not present but the joy is accentuated, in that it has two representations and is double-encoded with the icon and the hue. In examples three and four, the participant seems to have found their visual language and has used the identical combination of drawing, icon-boundary, and tokens, which she has named the "*the holy trinity of joy*", to depict the good examples of a junction. By a good example, I mean the junctions that are familiar to the participant and that they consider safe and easy to navigate. From this, we can see that working through maps has supported her thinking and the development of her visual phrasing. While marking the junction on the third map, she remarked:

"*Basically the combination of good infrastructure and traffic lights brings me joy....and the Old Street one is a total work of art.*"

In the table Table 4.9.4, we can see examples of the expression devices she has employed. There is a great reliance on colour and she uses it to:

- Classify - use of different colours for danger, passivity and confusion.
- Contrast - red warning signs next to green hearts.
- Accentuate a point - drawing a red joy symbol next to the token for joy.

However, the use of colour is not consistent across the maps. In map one, red was used with a negative connotation (danger) but in map two, it is used to communicate the extremity of positive emotion (joy) Table 4.9.3. In the third map only blue is used.

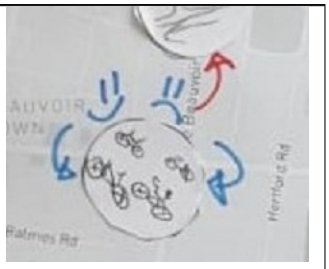
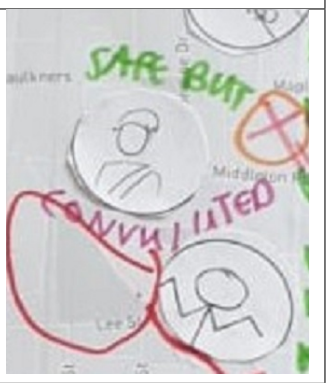
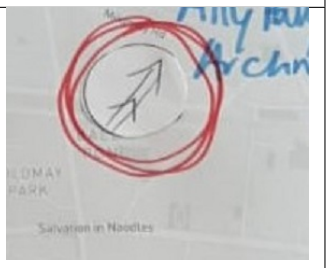
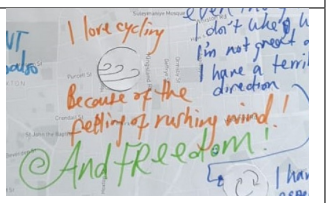
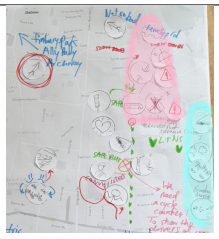
Visually **implied connections** between concepts Created own tokens	
Used hue to**create contrast** - here we see red depicting danger and green depicting a safe route for travel close to each other and to **classify concepts**	
Used double-encoding - In this example, the participant has used hue (green for safe and purple for complicated), tokens (safety and confusion) and text in order to ensure the contrast is communicated	
Created boundaries	
Used colour to **separate points** in writing	
Used **clustering** - we can see two clusters here. One marks the area with unsuitable cycling conditions and issues (highlighted in pink) and the other marks adjacent areas of pleasant and positive cycling environment.	

Table 4.9.4: [P1- Study 2] These are examples of visual expressions used by Participant One. Using drawings for the classification of tokens and creating connections between concepts, direct drawing, using hue to create contrast (green=safe and red=danger) and combining hue and text in order to make the text more readable and separate different points the participant was trying to make.

The main point (*complication*) of her story was told using a portion of map one, and in the image Figure 4.9.2 we can see how the tokens follow the participant's narrative. The introduction (yellow) was the opening statement regarding the difficulty of crossing a certain junction. The complication (pink) illustrates the issues they are facing in trying to find a safe path for the teen child to the secondary school they have recently started. Evaluation (blue) tells more about why this story is relevant and how it affects the family. Here we see that solutions are possible, as there are places in Hackney where entire routes are safer and the junctions cycle-friendly. Also, the change and the difficulty have an effect on the whole family as they now have to operate in a new geographical location, getting lost, and having to combine walking with cycling in order to manage challenging sections. In conclusion (brown) we hear that the direct route is possible but that it is not complete and that the participant is of the opinion that traffic-reducing schemes, such as LTNs work and should be expanded despite their own road experiencing a greater load of traffic.

The participant used a combination of techniques to tell their story. In Figure 4.9.6 we can see the flow of the actions and how the narrative binds with the materials that I provided. She introduced the narrative verbally and was map-led at the outset. She examined the tokens after she looked at the map but referred to them throughout the main interaction. While the tokens were not the primary source of the narrative, they did support it and provided some new avenues for discussion. For example, reflection on the interaction with *other cyclists* was prompted by seeing the token. Once she identified and stated the main argument (*complication*) in the first map, she proceeded to contextualize it and find examples in other maps. She concluded the session by returning to the first map in order to start a new narrative but soon lost interest in elaboration. She concluded with general reflections on cycling, which she documented by creating a type of **collage** that consisted of writing in different colours, using tokens, and drawing on maps. While she stated that she used the map for writing to "Save paper.", it is evident that having the map, and the tokens, influenced this reflective stage as she used more than one map, drew on the maps, marked things in position (she added a place where she would like a cycle counter) and used a map as a non-spatial background.

We can see that in Figure 4.9.7 where the participant drew the London Bridge story onto a different bridge. The similarity of the geography, enabled her to illustrate a point that she found of importance despite not having the map with the desired location.

For this participant, the maps helped her express and communicate a concrete issue and illustrate the thread of thinking on her family's mobility Figure 4.9.8. While the introduction was purely verbal, it was unfocused and it seemed to address what 'type' of cyclist the participant thinks she is. The maps and tokens focused the narrative and bound it spatially. This deteriorated in the conclusion where the participant reverted to verbal narrative and distanced it from geography.

Summary *"It's just a wholly trinity of the traffic light, bike paths, and big junction. The bike paths feed you into the junction the correct way, getting you through it with*

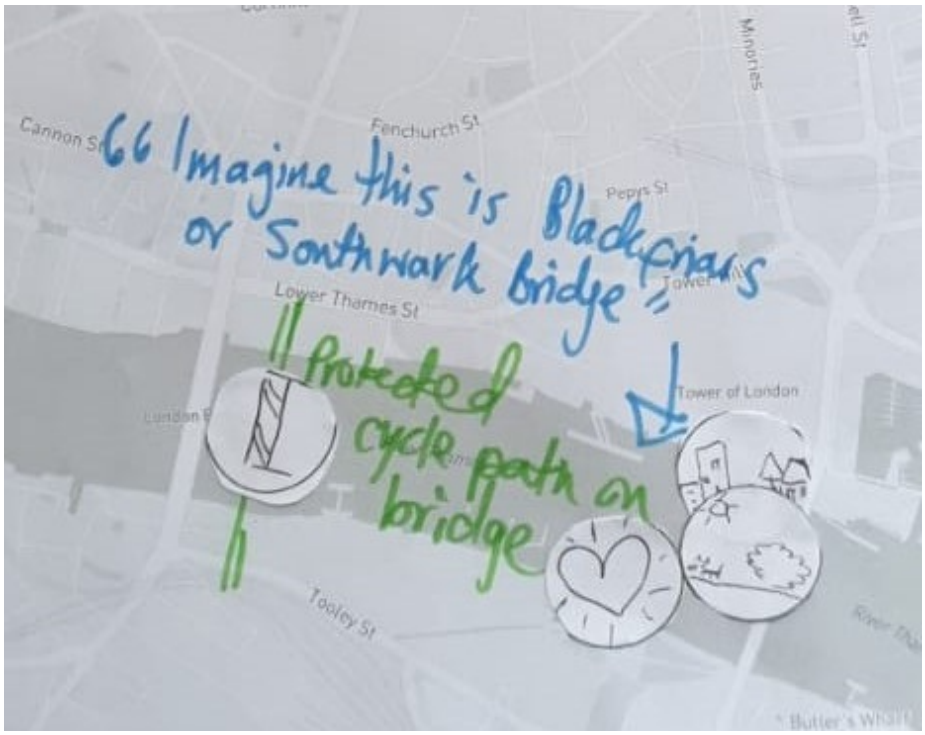


Figure 4.9.7: [P1- Study 2] Participant One has London Bridge transposed onto a map of Whitechapel.

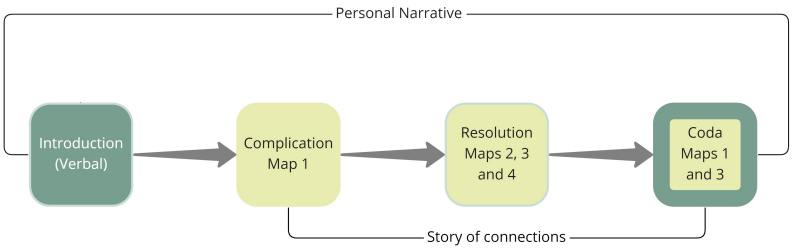


Figure 4.9.8: [P1- Study 2] Participant One narrative structure in respect of maps.

Map one	Map two	Map three	Map four

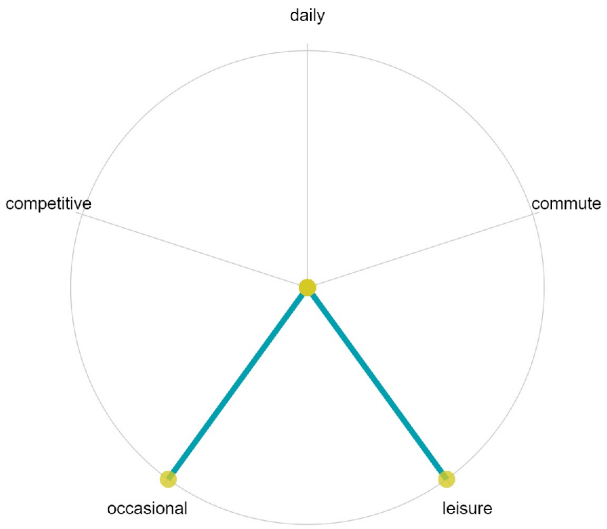
Table 4.9.5: [P1- Study 2] Participant One progression of the expression development from map one to map four.

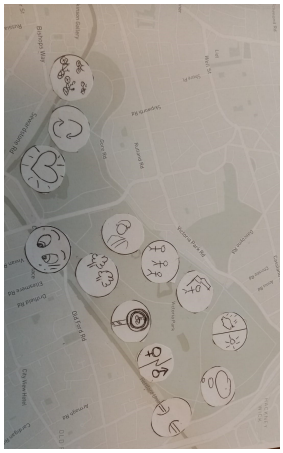
ample space and time. And it means you can take children across the big junctions. ***And this is my big thing. As an adult, on my own, I can go anywhere but I can't take children places.*** *"*

The participant has children who are both dependent and independent cyclists. Family mobility takes precedence over the participant's own cycling. The ability of the environment to facilitate their various travel needs (family unit cycling, independent teen cycling, cargo bike cycling) has a noticeable impact on their lives and activities. This is evident in the stories of the swimming lessons and the specialized library journeys. Both have only become possible once the infrastructure was upgraded to accommodate family travel and the cargo bike.

The participant had a circular structure of the flow, in that they started and finished the session with the same map. The start of the narrative was map-led, but once the story started to unfold, they sought out maps with the examples they wished to show. This eventually led to them abandoning the map content completely and using maps as a canvas for writing and drawing. While writing and drawing, they used colour for classification, contrast, and emphasis Table 4.9.4.

4.9.2 PARTICIPANT TWO - P2





P2's visual persona | P2's mapping

Table 4.9.6: Visual stamp of self-identified cycling activity and an example of output participant has created..

- **Gender:** Female
- **Profession :** Teacher
- **Age :** 50-70
- **Ethnicity:** British
- **Importance of cycling for self-expression :** Extremely

Abstract: P2 volunteered for the study after visiting Dr Bike's Walthamstaw event. She attended with her partner as cycling is their usual weekend activity. At the moment, P2 is unemployed and not needing work as she is semi-retired. She is in a position where she can choose to work, and has recently refused a post as the organisation was not willing to place her in a location that is a feasible cycle distance. At the moment, P2 does two types of cycling, social outings and errand completion. The errands are mainly daily chores and small shopping.

This participant is new to the area but is an active cyclist and has engaged with the environment a great deal. Cycling is important to her as it is not only a preferred mode of transport but also significant for her relationship. She met her husband through cycling and it is something they do together regularly. This is reflected in her map choices and the narrative, as the map that P2 devoted the most attention to contained the couple's favourite destination.

The second activity she wanted to discuss was utility cycling. P2 cycles to the shops and to complete chores. This is a different experience as she has to cycle in an environment that she considers less than optimal. The majority of tokens in this section were used to express friction: *safety, potholes, no parking, buses, other cyclists and no joy.*

Introduction - Map One P2's first choice of the map was her regular trip to Victoria Park with her partner. She **set the scene** by stating the aim and with the description of the destination itself.

"*It is one of my favourite places to go with my husband. It makes me happy."*

She used tokens that described the visual environment (trees, nature) and her feelings (joy).

From setting the scene she progressed to the description of **conflict** by introducing a *pedestrians* token and placing it within the park. The conflict centers on the congestion and issues that arise from shared spaces. There is uncertainty as to which part of the provision is suitable for which mode of travel (lack of *signs*), the riding is disrupted (*break in flow*, and riders have to be vigilant (*alert*). There is a lot of ambiguity in her use of tokens as some are assigned both positive and negative qualities. For example, the token 'cyclists' was both positive as the presence of many people on bikes signals the popularity of the activity, and bad as it causes congestion on the narrow paths. Traffic is bad but when at a standstill and polluting, but on the bicycle, you can pass it and it is quite fun.

"*Other cyclists is both good and bad really, I think it's good in the sense that other people are taking advantage of being out and about on a bike it's also bad because there is quite a lot of congestion. We share with pedestrians. Cyclists have to get off their bikes quite a lot at the bridges (as the space is narrow) and so on to allow pedestrians to pass. It does slow down your journey significantly pedestrians, but it's still you know, if you're not in a hurry, if you're doing it for leisure pleasure, then you know it's just a part of the experience really* "

She **reflected** on the creation of memories (*memory token*), on the journey fluidity by commenting that it is quite broken due to other users (*Break in flow*) and the dynamics between her and her husband when cycling (*gender-clash*). The relationship appears equal as they take turns to lead when cycling but that equality must have been achieved through some discussion for this to merit mention and a token. She also talked about the meditative nature of cycling (*thinking*) and how the weather conditions affect their decision to cycle (*weather*). Finally, she reflected on the freedom and flexibility cycling affords to individuals (*independence*).

"*You can go wherever you want, whenever you want. You don't need to change buses or anything*"

She concluded with remarks regarding the role of people in her cycling life. People are important as cycling is a social activity for P2. She goes on organized rides and bonds with her husband through their shared love for it.

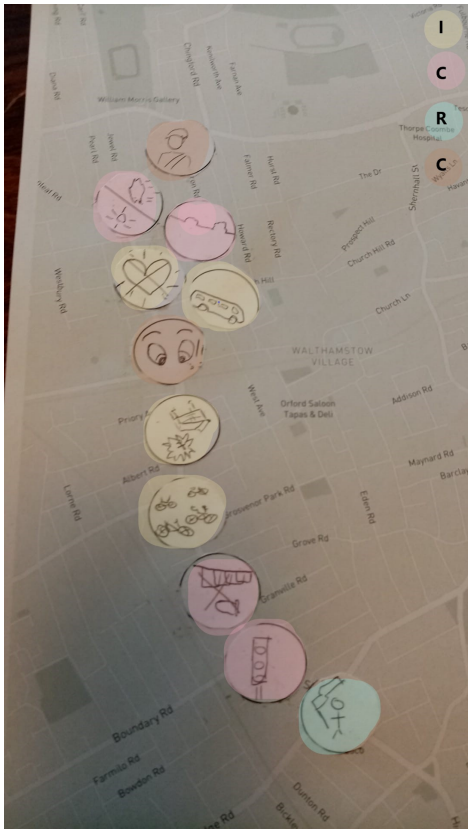


Figure 4.9.9: [P2- Study 2] This is the enhancement of the first map that Participant Two has produced. The tokens are coloured based on the part of the narrative they belong to. Yellow tokens are the opening statement, pink tokens are the issues that she encounters, blue tokens are reflections, and brown tokens are the closing thoughts. The token *people* is coloured with two hues as it was first used in the context of path congestion and then, in the closing statement, to support and illustrate the social aspect of cycling.

Conflict - Map Two

"*That it is a different kind of experience. I avoid it. I try and find backstreets, or whatever. I hate it...It is just madness along there.*"

P2's tone of voice and speed of talking changed as she introduces this section. She **introduces** this map by explaining that this is a destination that she prefers to avoid, but it has resources that she needs in her life(*shops*. She sounds angry, her speech speeds up and the pitch of her voice is higher. The first thing that she wishes to communicate is traffic (*bus*). She perceives the area as the one that cyclists avoid (*cyclists*) and the unease she feels as a cyclist in the area (*joy crossed out*).

The environment is hostile and difficult to navigate (*traffic light, potholes, buses, no cycle parking*). This is a clear **problem** and P2 goes through the issues quite fast, not seeming to want to dwell on it. Her tone is cross and dismissive.

She proceeds to go through the tokens and **reflects** on the effect bad weather

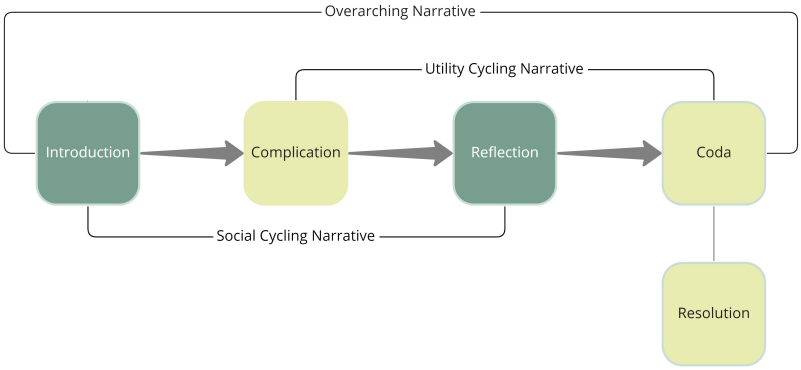


Figure 4.9.10: [P2- Study 2] Participant Two used each map to tell a sub-story of their overall narrative. This diagram shows the structure they gave their story. They devoted two maps to social cycling (green sections) and two maps to utility cycling (yellow sections). The maps form an overall narrative as they can each be placed in a narrative structure. There is another map, received after the interview. This is a map that P2 has sent additionally and it contains an alternative route for the utility trip. It is a partial solution for the issues that she discussed in the *conflict* map and it has a role of *resolution*.

has on her decision to cycle. This is a topic that she mentioned in the previous map, where she was quite tolerant of it. In this case, she is using it to illustrate how easily she is persuaded not to cycle when needing to go to this destination (*weather*). She ruminates on her ability to shop and her readiness is adversely affected by the environment that is not ready to accommodate cycling individuals.

She does not feel safe (*safety crossed out*) but concludes that despite the issues, cycling is the best mode of transport to reach the area quickly as the traffic is congested and public transport provision is affected by this. Cycling gives her control over the timing of her trips and a better idea of the length of the journey as she won't be delayed by traffic jams (*independence*).

Her **structure** was less evident here as she seemed in a rush and raced through the tokens. There was a lot of repetition, both in tokens and in her speech. The tokens are used for emphasis; the bus token is revisited several times; she used two tokens to express her unease (*alert, safety crossed out*). She iterated the fact that she avoided the area several times.

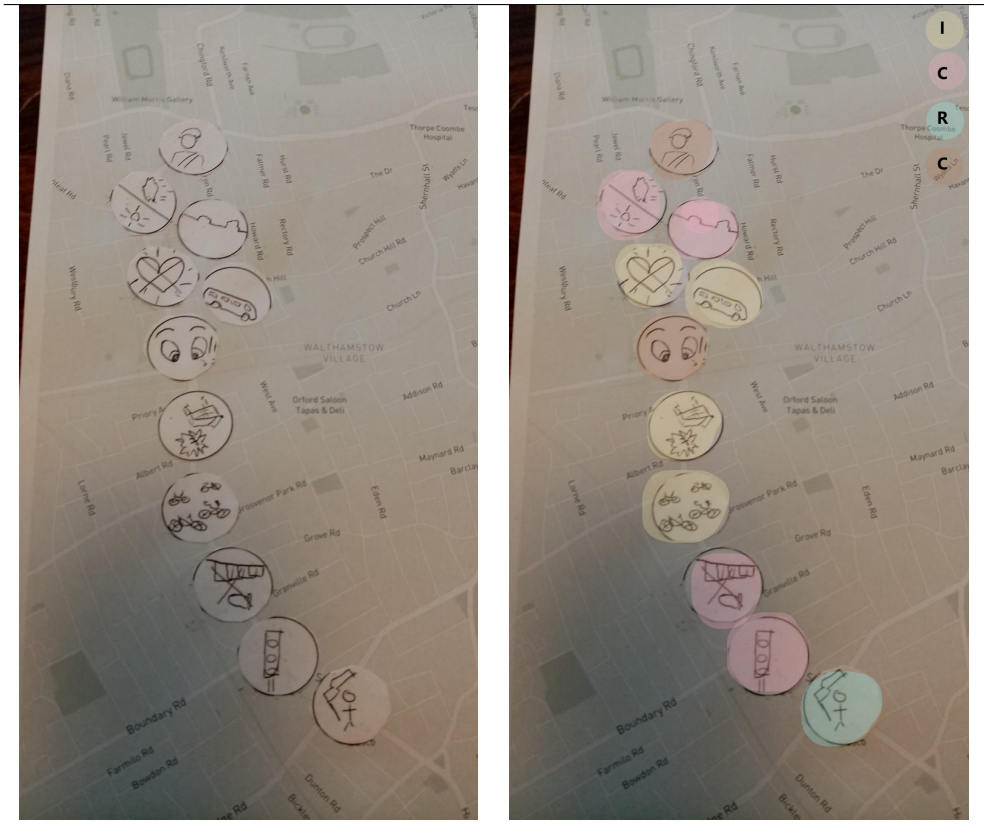
Evaluation/Reflection - Maps Three and Four

Revisiting leisure (Map Three)

"*It was quite restricted as it was not very clear where we could cycle and we got in trouble and were told off.*"

She opens with a statement that this is a different experience from Victoria Park, as it's unfamiliar and not clearly signposted (*no signs*). She describes the setting by explaining what route they followed and sets the scene by describing an anecdote of them getting into trouble for riding on the wrong path.

She follows that with a discussion on shared spaces.



The map P2 produced	The map with allocations in the narrative

Table 4.9.7: [P2- Study 2] This is the second map Participant Two has produced. It is the mapping of a utility destination as it is an area with shops and trades. On the left is the map P2 has produced and on the right, is the same map but the tokens are marked as they appear in the narrative.

"*You know, in these spaces, it would be so helpful, just to know which are pedestrian spaces and which are shared spaces.*"

P2 contradicted herself by stating that it was both quiet and full of pedestrians. She **reflected** on the usability of nearby roads but did not use tokens to illustrate her point. She was reluctant to talk about experiences outside the park and swiftly moved on whenever she touched on the subject. This might be due to the fact that social interaction is minimal when cycling on busy roads and the social aspect is the core of the park outings. This is evident in her **conclusion** that it was a happy event and a very pleasant day out (*joy*).

When asked if there was anything she could add that is not captured in tokens, she described frustration with the public map (a map displayed outside the train station) as it did not include information for cyclists. This leads to P2 bringing the conversation to the present and her general involvement with maps.

Revisiting utility (Map Four)

The last map she chose is the map of her neighborhood. She opens up by listing all the places she is familiar with **orienting** herself and the narrative.

The **complication** is introduced by discussing difficulties with navigation (*lack of signs, confusion*) as there is a lack of clarity. The measures for regulation are are lacking and signaling is (*traffic lights* but insufficient.

"*I don't feel comfortable crossing the road. There is no crossing so I cycle on the wrong side of the road to the traffic lights with people being helpful and telling me: you are on the wrong side of the road. As if I didn't know.*"(*rule-breaking token*)

This is an issue that is not confined to the local area as P2 avoids challenging cycling situations such as roundabouts. She has a strong sense of order and the cyclists that do not use infrastructure annoy her despite her being aware of some of its shortcomings.

She ruminates on urban cycling (*pollution, built environment, shops* and contrasts it with the experience of leisure cycling which she favors.

At this point, she is wrapping up her story and filling in what she might have missed. For example, she adds a token that she missed on the Hampstead map (*uphill*).

She states that, if possible, she will find an alternative route that takes her through the park, even if it is a longer route.

"*I never choose the most direct route, I always choose the backstreet routes if I am not in a hurry.*

Resolution - For this individual, the more challenging aspect of cycling is the utility. The resolutions lie in a sense of independence and empowerment. P2 is solving her issues by *explorative cycling*. She is trying new routes and is learning by trial and error. At the end of our session, she printed off a map with a route that she has discovered and which is less stressful for her. It seemed very important for her to share this with me and she mentioned it several times during the interview.

At the end of the interview, she repeated that they moved to this area recently and that she does not know it well yet.

Structure of the expression The participant used *distinct maps* to express herelves. Each map was a destination and an experience she wanted to discuss, this makes it a sub-story to the general narrative. The participant did not attempt to use the whole space or illustrate the entire journey with the tokens. Instead, in each map, she chose a destination and used that as an **anchor** for her narrative.

The participant felt no need to draw on the map and did not mark the routes or use bounding. The tokens were *grouped* and *no new tokens* were created. The participant *modified* tokens, such as joy (crossed out) and parking. The meaning of tokens was context-dependent and sometimes the positive/negative classification unambiguous. For example, other cyclists are both good (foster a sense of belonging) and bad (congestion).

There were some instances of repetition in speech and some of the items that were repeated were not represented in tokens. In the first map, the issues P2 talked

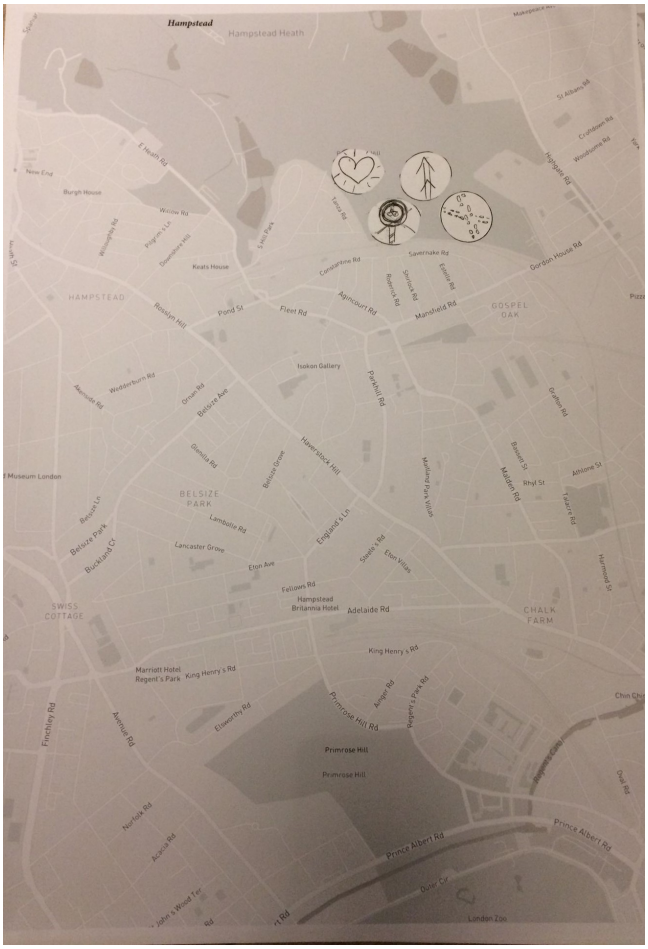


Figure 4.9.11: [P2- Study 2] This is an image of the entire map and we can see that Participant Two has constrained her augmentation to a small section of the destination.

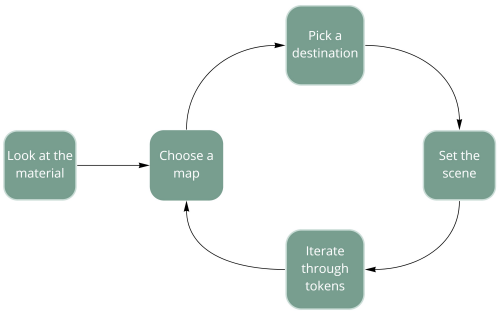


Figure 4.9.12: [P2- Study 2] Participant Two has developed her own pattern of action. She iterated finding familiar areas, identifying destinations and searching through tokens for relevant icons. This process was repeated until there was nothing new to add and saturation was reached.

about more than once were:

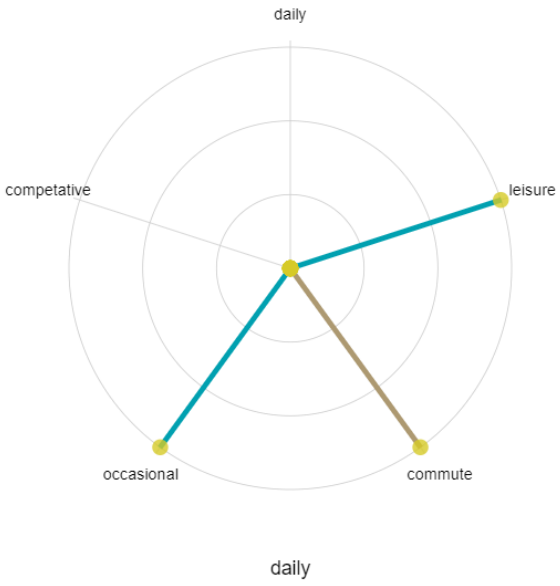
- Happiness - P2 has used the token for joy but has not modified it or augmented it to enhance its importance, despite mentioning feeling happy at Victoria Park and spending leisure time there with her husband several times.
- The coffee shop - this destination has a special significance for P2, however, she did not opt to create a sign for it.
- Unease in sharing space and congestion - even though this was not declared as a vital problem in speech, P2 mentioned the issue in three separate sections and repeatedly mentioned other cyclists and pedestrians.
- The bridges on the towpath - the area under the bridges is narrow and affords little visibility of the oncoming traffic. P2 mentioned bridges a couple of times in speech but did not attempt to make a token or mark the towpath.

Through the use of tokens and the narrative, P2 has introduced her position in relation to cycling and laid out the **setting** for the rest of the interview. Figure Figure 4.9.9 Table 4.9.2 shows the flow of her story in tokens. In map one, she opened with what draws her to cycling and what she gets out of it (yellow tokens). Following that she introduced some difficulties (pink tokens) and reflected on non-spatially bound aspects (blue tokens), to conclude with more personal considerations (brown tokens).

In the diagram Figure 4.9.12 we can see the iterative process the participant developed where maps and tokens helped her structure the narrative. The maps gave settings, while the tokens were signposts; they helped structure the narrative but did not limit the topics. An example is an independent token which led to participants disclosing the importance of control over the timings of their journey, and that this takes precedence over a hostile environment. For this participant, it is possible to compare her expressiveness in regard to cycling with and without maps and tokens as she engaged in conversation with me at the time of the recruitment. There are some similarities between what she expressed during the session and what she

talked about when we first met, in that she mentioned the importance of cycling for her and her husband as well as her fondness for Victoria Park. However, without the maps and tokens, the scope and detail were much more limited.

4.9.3 PARTICIPANT THREE - P3 - WHERE IS THE MIDDLE LANE?





P3's visual persona	P3's mapping

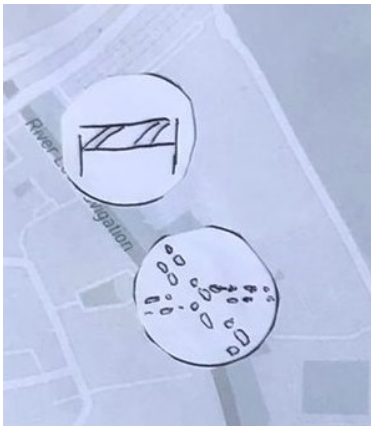
Table 4.9.8: Visual stamp of self-identified cycling activity and an example of output the participant has created.

- **Gender:Male**
- **Profession : Youth worker**
- **Age : 50 - 70**
- **Ethnicity:** British
- **Importance of cycling for self-expression :** Slightly

Abstract: This participant is a mature cyclist living in social housing. His story is centered on the tension between other road users, infrastructure, and him. He chose the maps he wanted to examine at the start of the session and did not expand from that. He did not talk during the exercise, despite attempts to prompt him, but he did discuss his outputs. The first journey he discussed was his commute to work. Other journeys he mentioned were utility and leisure. He drives a car but sees cycling as

faster and more convenient. Despite having a car and cycling, the transport sub-user group he most identifies with is pedestrians.

Introduction - Map one - Commute "*I work at the Olympic Park so my commute is Upper Clapton*"



Shared path as a barrier to cycling



Joy and barriers

Table 4.9.9: [P3- Study 2] Participant Three combines pedestrians and barrier tokens to mark the difficult environment (left) and contrasts this with the park that is cycle-friendly.

The participant introduced his cycling by describing his most frequent journey, which is his commute to work. His place of work and his residence are connected by a canal, which has a towpath along its entire length. The towpath is a popular destination for leisure, dog-walking and jogging. It is also a cycle-way. However, he finds the towpath, with its mixture of fast cyclists and pedestrians, stressful; hence he takes alternative routes through the back streets of the residential area Table 4.9.9. He sees other (fast) cyclists as a big problem as he perceives them as an aggressive and poor representation of the majority of the people who travel by bicycle. One of the reasons he thinks they are a problem is that cycling infrastructure is not suitable for fast cycling. Also, fast cyclists give other cyclists a bad name as they often break rules, and lastly, they make him feel unsafe as he cannot hear them approaching.

"*I feel sad that I can't cycle down the canal as that would be the fastest route for me*"

Despite cycling a lot and being a car owner, he identifies most with pedestrians and prefers pedestrian-friendly infrastructure over cycle-friendly. For example, he identifies the reason that he likes cycling in the park as being because it is made for pedestrians, and he has a negative opinion of the local Mini Holland cycling infrastructure, which is generally well-received and has increased both cycling and walking in the borough [128]. The criticism of the cycling infrastructure is twofold. Firstly, he finds it confusing, as the new layout is not embedded in the cycling or driving behaviors and he is unsure of the most appropriate and safe way to use it. Secondly, he thinks that pedestrians are not sufficiently protected from fast cyclists.

He identifies parks and the cycling infrastructure with safety.

"*The closer I get to the park the easier it gets for me.*"

This is also evident in that he has placed several *joy* tokens within the park boundaries and book-ended it on both sides with the *barrier* tokens Table 4.9.9.



Stoke Newington | Lower Clapton

Table 4.9.10: [P3- Study 2] Participant Three maps where both maps have strong polarities in presenting *barriers* vs *joy* which relate to specific geographies but both also have *independence* which is not spatially bound.

The participant finds the main roads intimidating and confusing. The infrastructure there is challenging due to complex one-way systems, speed regulating measures (speed humps), and unmaintained road surfaces. He favours using back streets to avoid traffic and because he likes to explore.

"*I know which lane I need to be in but I feel very vulnerable in that lane.*"

He describes a couple of journeys he makes for utility purposes Table 4.9.10. One to a major supermarket and one to a local independent shop. On both journeys, he has to negotiate busy traffic, junctions, and multi-lane roads. He finds negotiating this intimidating and at times confusing. He believes that the rest of the traffic users are equally unsure of the most appropriate actions and this heightens his sense of unease.

Coda In the final discussion, the participant elaborated on the previous statement that he likes exploring. He changes his route often as he sees cycling as more than transport. He sees it as an adventure, as it gets him closer to his environment, enabling him to know it and connect with it.

He commented that his favourite journey (cycling by the canal) is subject to seasonal change as the canal is less busy in the winter, hence he uses it more.

Structure and expression

"*I might add some if I talk it through them with you*"

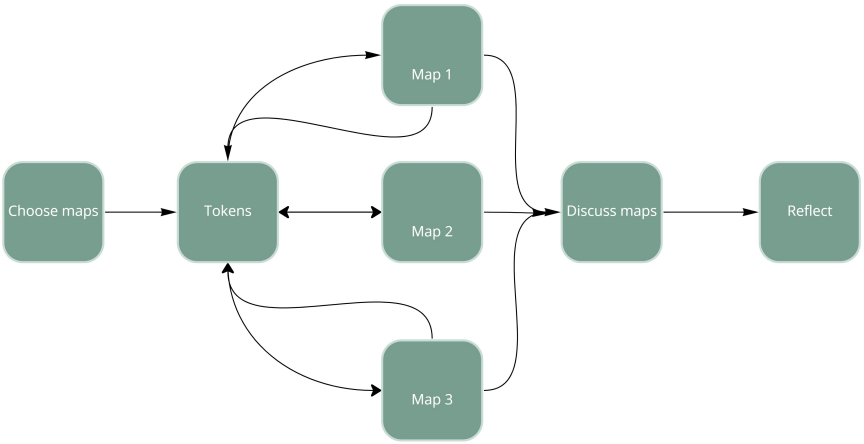


Figure 4.9.13: [P3- Study 2] Participant Three has worked on all three maps simultaneously.

The participant decided what maps he wanted to use after the first look at the materials. Despite me asking him for commentary, he worked on the maps in silence. However, after completing the token work, he was very keen to share what he had created. While he worked on the maps, he did not join them, despite the areas being adjacent. When discussing the outputs he discussed them together and it seems that he worked on them simultaneously Figure 4.9.13. He worked rapidly and with purpose. His overall narrative was told over two mini-stories; a commute to work and visiting shops.

Many tokens, like (*bike shop, wind*) are location specific but, he also used abstract tokens *independence* and *joy*.

He contained his expression to the tokens that I provided and did not use any other materials (colouring pens) nor did he make/modify the tokens. In the majority of his work, he used straightforward literate placing without embellishment. However, he used reinforcement by placement of multiple tokens with the same meaning next to each other Figure 4.9.13 and a combination of tokens to express layered concepts such as choosing to cycle as it gives him *independence* Table 4.9.10 despite experiencing *confusion* and facing *barriers*. He did this by grouping tokens.

After receiving maps from him, following the session, it transpired that some tokens were used but not discussed. These tokens are for *bike repair shop* and *wind*.

Summary Participant Three has strong, polarised associations that are geographically bound. The green spaces bring him *joy* while cycling in traffic, and even cycling infrastructure is stressful and *confusing*. He finds main thoroughfares and even the cycle lanes intimidating as he feels that there is insufficient support and clarity as to the rules for people who cycle.

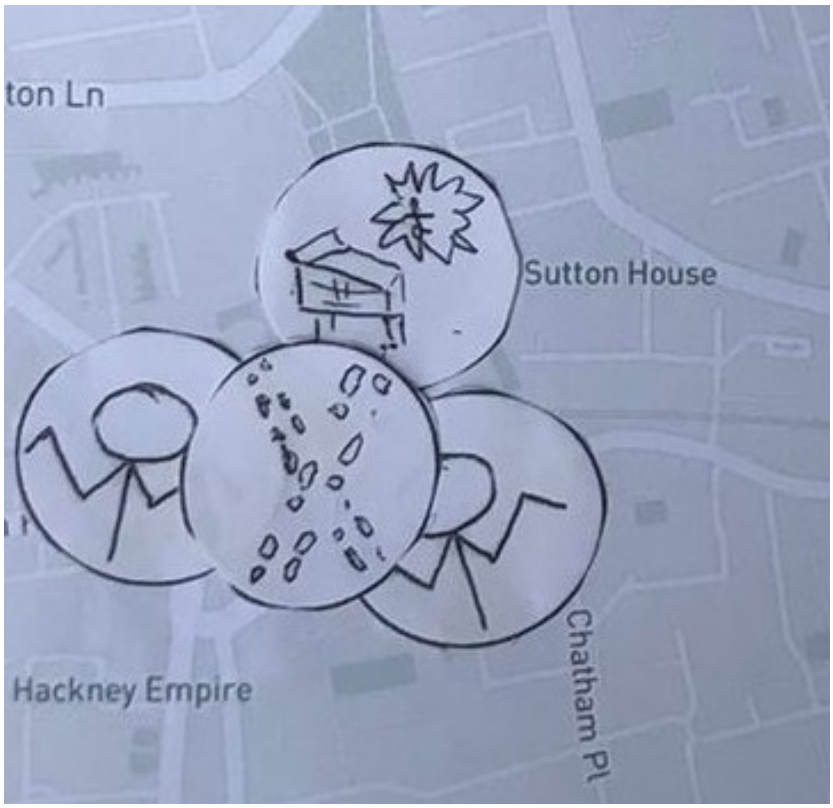
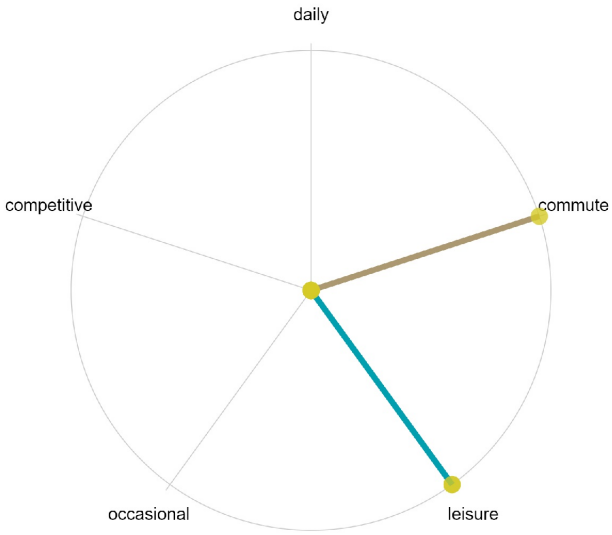
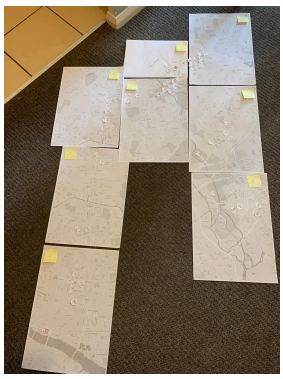


Figure 4.9.14: [P3- Study 2] In this instance, Participant Three is using two *confusion* tokens to reinforce the main issue he is trying to communicate.

Both P2 and this participant([P3- Study 2]) have observed difficulties in navigating the towpath and sharing this space with pedestrians and other cyclists. It seems that the width of the path is not sufficient to accommodate the traffic of different speeds (walking - slow, some cyclists - fast, some cyclists - medium speed) and this is a cause of frustration. The reactions that the two participants displayed differed in that P2 was less affected by the frustration. This might be due to P2 using the towpath for leisure, which is less pressured than a work commute that P3 is using it for.

4.9.4 PARTICIPANT FOUR - P4





P4 visual persona	P4 mapping

Table 4.9.11: .

- **Gender:** Female
- **Profession :** Social Worker
- **Age :** 30-50
- **Ethnicity:** British
- **Importance of cycling for self-expression :** Very

Abstract: This participant is a cycling advocate and volunteers as a ride leader with a women-cycling advocacy group. The said advocacy group collaborates with other

cycling organisations and often runs sessions alongside Dr Bike, where this participant came across my leaflet. Despite her involvement in advocacy, taking part in group rides and her multi-purpose cycling ("I cycle everywhere, whatever I need to do, I go by bicycle."), for this discussion, she has chosen a solitary long journey. She is a young woman and says that cycling gives her independence and agency but it also makes her feel exposed in some situations (cycling through areas with reported crime).

Introduction - The journey of independence and autonomy: maps 1- 2

"*I think that is my first thought whenever I get on the bike, a rush of independence.*"

The participant has described her work commute and to do that has combined maps into a bigger geography (sticking individual maps to make a larger map). Even though she finds setting off on a cycling journey positive, her close neighbourhood is congested and noisy, so the cycling infrastructure does not make her feel protected Figure 4.9.15.

"*Is there a sign for a bad infrastructure?*"

She uses red colour to communicate the alertness and the sense of danger in this area. The tokens are bunched around a small area in a way that brings to mind clutter Figure 4.9.15. That echoes her narrative as she states that the area is a bottleneck with slow-moving traffic, vehicles going into each other's lanes and pedestrians stepping out unexpectedly.

Conflict - Always on the alert (A personal journey) - maps 3 - 6 This participant enjoys cycling and finds beauty and *joy* in most of her journey. She notices, and values, *nature,* she has a sense of peace, space to *think* in quiet stretches and is appreciative of the landscape and the views she sees Table 4.9.13. The strife of her immediate neighbourhood contrasts with the section that follows, which is leafy, has signs, and is segregated. The transition in itself brings *joy.* The feeling is reinforced by the presence of a cycle counter that introduces a sense of belonging. The positive feelings that are elicited due to good cycling provision are diminished by the participant's awareness that this is an area with a high crime rate, and even though being on a bike gives some sense of safety, she feels exposed.

The next section of her journey is coloured by a *memory* of an incident. She was pushed off the path and onto the road by another cyclist. Thus, despite the segregated path, she is wary of interaction with other wheeled users, as well as *pedestrians* stepping out. Male riders are especially perceived as aggressive, which she signals with a *gender-clash.* Another group she considers a threat to safety is people who rent bikes per hour (also called bike sharing). Bike sharing is gaining in popularity in cities that wish to provide accessible active travel [210]. Most cities make anonymised bike-sharing data open source and it has been widely accepted as a good source for the analysis of cycling behaviour. Beecham and Wood use origin-destination data in combination with users' demographics and other data sets to explore behaviours, trends, and uncover patterns and factors which influence where, how, and who, cycles in London [26, 24]. However, no work has been done with the

scheme users to explore their attitude to cycling.

During the interview, a couple of distinct themes emerged. The first one was that this participant has an active relationship with the environment and enjoys the act of cycling. She made note of this by putting tokens for *joy, vista* and *nature* on each of the maps. Each area she discussed had a layer of appreciation and introspection regardless of other factors Table 4.9.12.

"*I have to be alert there but there is always nice new graffiti and I slow down to have a look at them and enjoy them.*"



Street art	Quiet	Introspection

Table 4.9.12: [P4- Study 2] Participant Four actively takes notice of her environment while she cycles. This is sometimes street art, sometimes quiet and an opportunity for introspection.

The appreciation of landscapes and introspection is in constant tension with the need for vigilance. From the onset, this participant her their safety. In the first map, the danger is from motor vehicles and rule-breaking pedestrians, while in the second map, it is awareness of crime rates in the area. In the third and fourth maps, there are distinct memories of incidents where the participants was accosted or had a near-miss. Along the route in all the maps, the participant placed tokens for *pedestrians* as she needed to be on the *alert* for them throughout. Out of eight maps, four contain a token for *anxiety* that she had devised at the beginning of our session.

"*They have no road sense over there and it is just horrible to cycle through.*"

She acknowledges that the different areas she passes through facilitate different types of cycling, and associates her own identity with that of her surroundings.

"*Once you get there, it feels like the start of being like a real cyclist.*"

Even to the point of feeling like a tourists at the end of her journey, where she is surrounded by landmarks. In this section, she substitutes the icon for a *vista* depicting a mountain, with a *camera.*

Resolution: Social cycling - Maps 7-8 The last two maps that the participant added to their super-map were two areas that connect the commute journey with the Olympic Park (a large cycle and pedestrian-friendly space in London) and its adjacent shopping center. She mentions that this destination is related to social activities, but will also be her new commute as she is taking on a new post at work. She does not pursue any auto-reflection on the other types of cycling and returns to commuting. This seems to affirm her intention to communicate the flow, beauty,

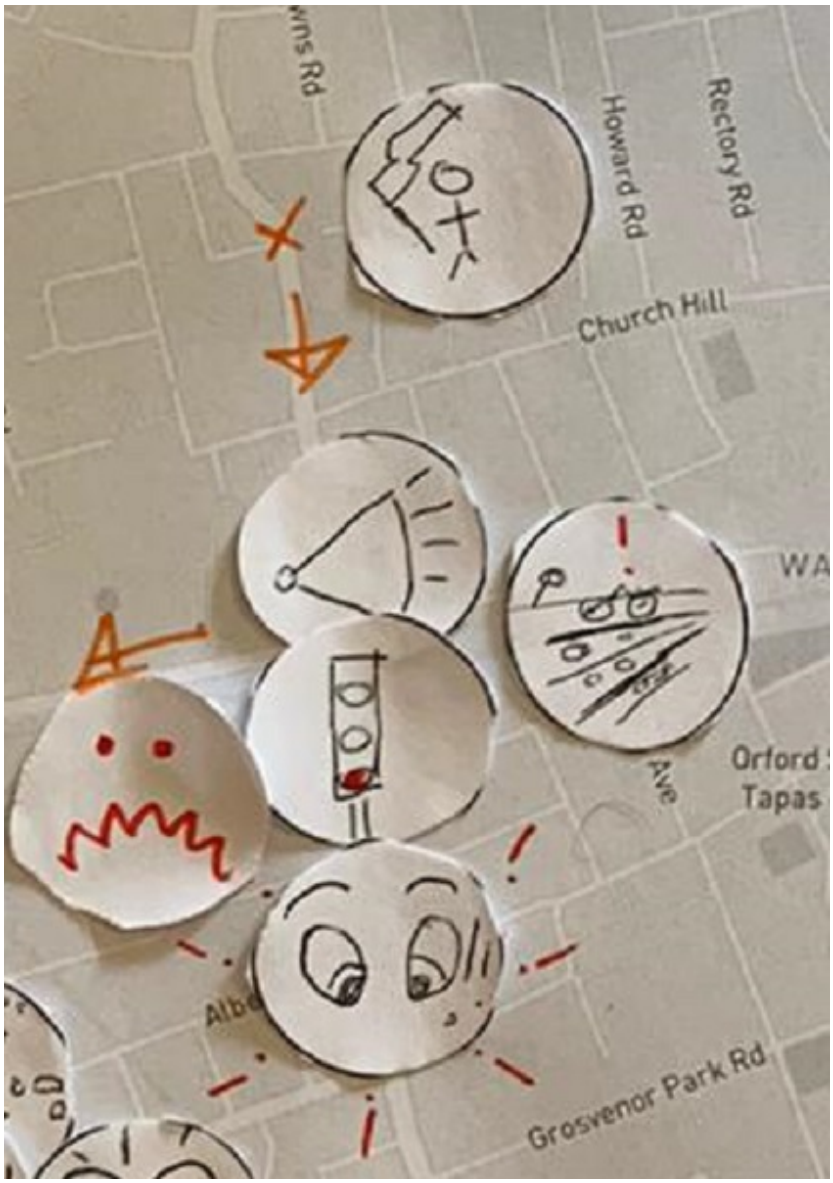


Figure 4.9.15: [P4- Study 2] For Participant Four independence is important despite unfavourable cycling conditions.



At lights



View in nature



Over the bridge

Table 4.9.13: [P4- Study 2] The environment and vistas are important to Participant Four and she takes note of them even in the traffic or when there is a lot of other stimulus. Here we see two different representations for the vista. One is a mountain and one is a camera.

and precariousness of her daily journey.

She repeated the themes from her previous route but in an abridged format. These clusters contained fewer tokens and were not discussed at length.

She noted the *joy* in *nature* and identified a green corridor on the route. Both maps contained areas of *anxiety* due to concerns for *safety* and *faulty infrastructure*.

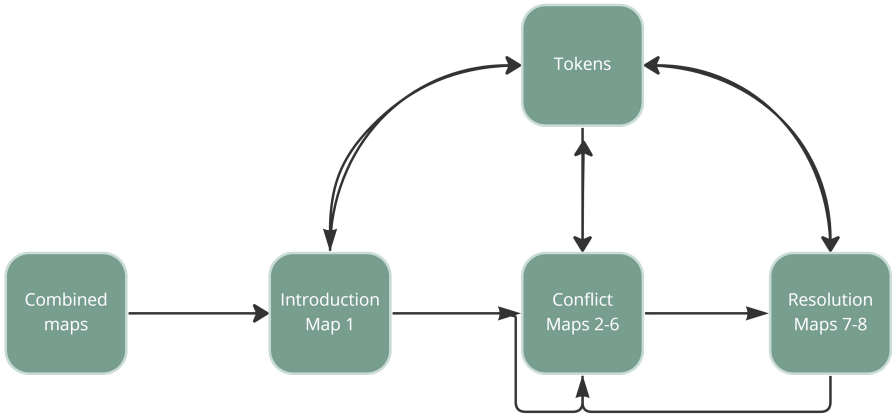


Figure 4.9.16: [P4- Study 2] Participant Four consulted tokens while following the route. However, she revisited areas while discussing conflict and themes in the resolution.

Structure: This participant combined the individual maps into a custom map that covered her usual cycle routes. She noted that tokens cover a good range of cycling themes and made use of concrete and abstract tokens. While combining the maps she observed that a small section of the route was not present, so she used the blank paper to add it and complete the trail Figure 4.9.17. This part of the journey was important as it provided a contrast to the previous section. Later, during

the session, she was reflecting on the importance of the natural environment while cycling and added a rough indication of a green space onto the additional map.

She used punctuation, hue, and symbols to prioritise some tokens and add attributes. In Figure 4.9.15 we can see the use of the colour red to signify high importance, combined with examination marks organized in a star-burst pattern reminiscent of a flashing light (often signifying alarm). The colour and annotations were used for classification (e.g. red-negative and green-positive) and to create a hierarchy (to signify what is of greater importance). She extended classification and created contrast by clustering tokens with positive association and augmentations (green), next to the ones with negative (red) Figure 4.9.18. "*I might add a little exclamation mark to give the alert a bit of priority.*"

The participant experiences the journey in sections and has placed the tokens in groups accordingly. From the interview, it transpires that this was not a deliberate action but a subconscious reflection of her experience.

"*So, here, this is where I feel like Central London cycling starts. I quite like it because you suddenly feel like you are like a real commuter. Once you get there, it feels like the start of you are a real cyclist.*"

"*When I reach this I feel like I am almost home and can relax.*"

This participant had a clear idea of what geography she wished to explore and was systematic in accomplishing that Figure 4.9.16. As the participant combined the sections of the map and had the entire area displayed, it was easy for her to revisit areas she had already discussed and add tokens/augmentations. One of the examples is that while doing map three, and talking about the *joy* of cycling through the areas with green development, she realised that there is an important feature missing in map two and added a rough representation of a green corridor. As this was a large area (forest at the edge of London) a token would not be enough and the boundary with a diagonal striped grid was more communicative.

She added arrows in some areas to guide the reader (of the map) and indicate the direction as this is explicitly a journey from her residence to work. (We did not discuss whether she takes the same route on her way from work but, as participants in the first study have pointed out, the cycling conditions change depending on the time of day.)

For the exercise, she used all the materials provided. She employed colour to classify tokens (red for negative, green for positive and blue for pleasant) and to provide a hierarchy. Another hierarchical device she used was punctuation. As we can see in a Figure 4.9.15 the *alert* token is surrounded with several red exclamation marks, which gives it added urgency.

"*I am just adding an exclamation mark to indicate that it is there but not ideal (cycling infrastructure)*"



Figure 4.9.17: [P4- Study 2] Participant Four - Blank paper added to complete the route.

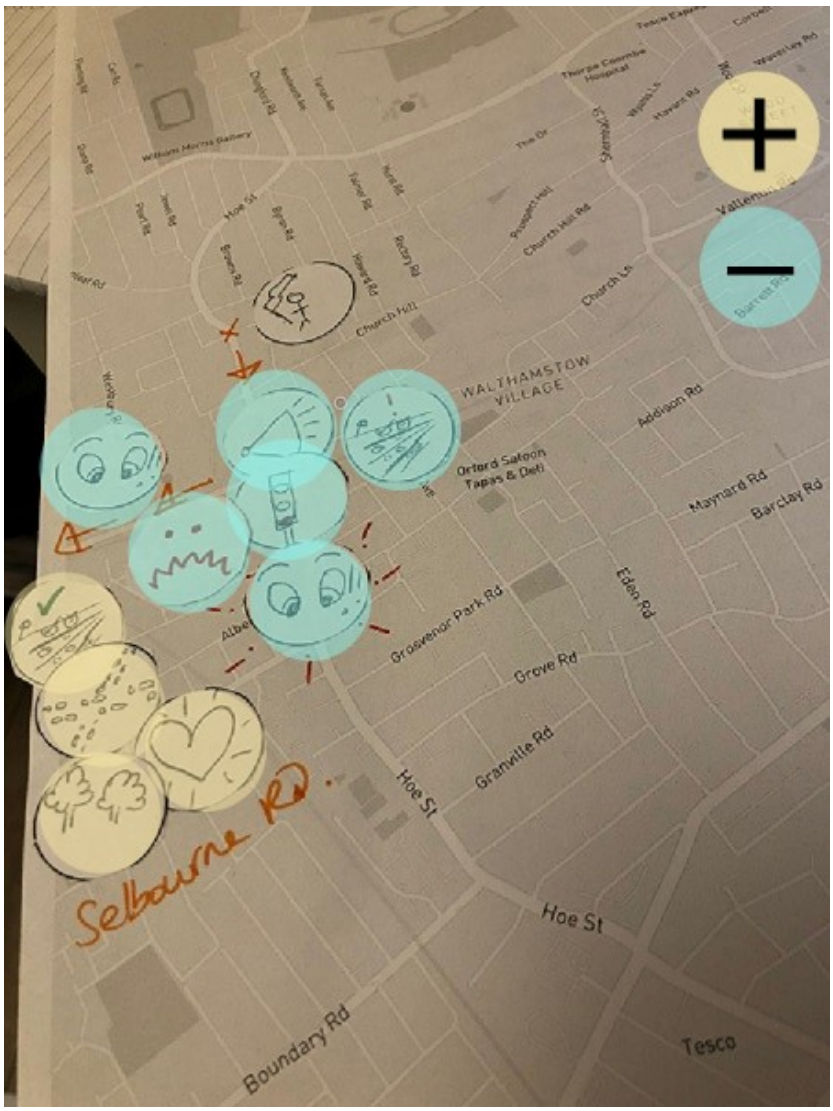


Figure 4.9.18: [P4- Study 2] Participant Four creates a contrast between good cycling provision and the ineffective one by clustering positive associated and negative associated tokens.

Summary:

"*Lots of conflicting emotions..there was loads of joy but also confusion and chaos.*"

Participant Four told us about her commute, which passes through several geographical and socially distinct areas. This appears to be a journey rather than travel as the participant actively engages in her surroundings by taking notice of and appreciating it (slowing down to see graffiti, admiring the view on the traffic lights). Her environment impacts her as she seems to align herself with it.

The journey she has described is from her residence to her place of work but not the other way around. I was not told if she takes the same route home, and if she does it is possible that her experiences are different as conditions vary at different times of day.

Part of the journey this participant takes overlaps with one of the journeys P1 has described. The overlap is more than just geographic as they share the negative experience of this area and use some of the same tokens to describe this: *buses, alert.* The overall impression both convey is negative and one of precarious safety. They differ in their view of *traffic lights* as one sees them as a calming measure, while the other as an obstacle and something that contributes to congestion of the area. A further observation is that despite, or maybe because of, the difficulties faced in this area, both participants have put an *independence* token nearby.

She structures her expression very effectively and uses all the materials in the pack. The combined maps give her a good overview and enable her to revisit previous sections to add tokens.

4.10 Discussion and Insights

P9 about the study: "*I feel like I'm getting into my stride. Reliving these journeys, thinking like, FINALLY I get to express all this stuff. I'm quite surprised I didn't expect to get into it this way. I'm thinking like yes, I have never communicated these thoughts.*"

.....

The sessions were embraced by the participants who engaged with the material and were keen to share their experiences. This study is an effort to look at cycling in a more holistic way and expose the changes and multiplicity of cycling needs that each cyclist experiences, thus contextualizing both the act of cycling and the data we collect relating to it.

Acquiring data in more traditional ways, such as counting, gives us a snapshot of one point in time, or a slice when doing a longitudinal study. Just as there is no one pill for all illnesses or one single answer for all questions, there is no one research into cycling that addresses all the issues and perspectives. This study also cannot provide all the answers but offers a framework for using maps and tangible tokens for collecting data and contextualizing it. Interactions with cities are not static, just as people's lives are not static. What we need changes according to season section 3.9, time of day section .3, the destination and the purpose of the trip subsection 4.9.2, changes in our circumstances, moving residence subsection 3.8.6 and life evolution, such as children growing up subsection 4.9.1.

The study was devised so that maps provide spatial, and tangible tokens cycling prompts, giving participants access to memories that go beyond the most recent, thus circumventing primacy bias [309] and helping them access their own experience. Participants' reactions, and the strength of their engagement (the shortest interview lasted an hour and a half, with the longest lasting almost three hours) strongly point towards success in engaging their interest.

This section provides a summary and analysis of the outputs they created, the way they interacted with them, and the themes that emerged. It is organized in the following way. The use of tokens and broader themes are discussed in the subsection 4.10.1, the map augmentations and token modifications in the subsection 4.10.2, how narrative related to materials in the subsection 4.10.3, and the themes and insights from the narrative analysis in the subsection 4.10.4.

4.10.1 Use of tokens - Looking at the broader themes

All the participants engaged with the maps and materials but used tokens to different degrees and in different ways. Hence, the number of tokens used per participant varied dramatically from 15 in one combined map to a total of 158 spread across several maps. In the introduction, I have outlined that the tokens are thematically divided into four categories:

- **Surroundings** - wind, trees, graffiti, environment, shop, nature, pollution, noise, construction, music, weather
- **Infrastructure, infrastructure actors and motorized transport** - bus, up/downhill, potholes, traffic light, bike repair, has signs, cars, good/no parking, infrastructure, barrier, break in flow.
- **Abstract terms that are implicit in the interaction with space.** - joy, confusion, barrier, memory, break in flow, thinking, alert, safety, independence
- **Interaction with society**- overtaking, gender clash, other cyclists, pedestrians, people.

Before discussing the results, I need to declare some caveats. Analyzing tokens qualitatively proved challenging due to their multifaceted meanings. When examining tokens statistically, independent of interviews, contextual nuances became elusive, particularly for themes straddling two categories, such as *barrier* (it could be physical or mental) and break-in-flow. Consequently, for statistical accuracy, I've classified them under the infrastructure category.

Similarly, looking at the visual outputs alone, it is difficult to discern if the participants were using the token for uphill, or downhill. For that reason, the arrows used in these cases are counted as *hill*. Furthermore, participants did not consistently apply the positive-negative distinction in cases such as "need signs" and "has signs," suggesting these should be amalgamated into a single theme: "signs." To gain further insights into how the participants related to the classes and themes, I calculated the proportion of each class per participant Eq subsection 4.10.1. This is how much of each participant's output was devoted to each category. We can see the results in the table Tab. Table 4.10.3. One thing to note is that being a percentage, the numbers in a column should add up to 100 and they do not in some cases. This is due to the rounding up of values. The table is divided by gender, with female participants on the left (P1 to P9), and males on the right (P4 to P12). If we look vertically, per participant, we can see that participants mostly used the tokens evenly, with a slightly smaller number of tokens in the interaction category across the board. There are a couple of outliers and we can see that two male participants have devoted 50% or more, of the total number of tokens to the infrastructure class, while one devoted 70% of his output to the abstract themes. For the rest of the cohort, the mode is 30%. We can also see that participants generally engaged with visual abstract themes. These were underrepresented in the first study's visual outputs but present in the interviews.

While the sample is too small for generalization or any definitive conclusions, we can see a difference between the frequency of tokens being used by female participants vs males. For all three male participants tokens representing surroundings comprised only 10% of their output, while the mode was 30% for female participants.

To further explore how the tokens were used, I calculated what range of themes within a class participants used. By themes, I mean what individual tokens repre-

sented. For example, **themes** joy and confusion that are represented by individual tokens belong to the **abstract** class Table 4.10.1.

This is a reflection on the usefulness and effectiveness of the vocabulary. The higher percentage means that the participant has used a wider range of themes and utilized more of the vocabulary provided. It can also tell us something about how the participants relate to their environment when cycling. In this sample, female cyclists used a more diverse set of tokens to express themselves than males, in all categories. The range for female participants is from 40 to 100% of token per class use, while for males it is from 0 to 50 % Table 4.10.3.

The summary of the themes range Tab. Table 4.10.2, also shows that the female participants used tokens to represent approximately 30% more themes within the classes, across all classes.

$$\textit{Class distribution} = \frac{\textit{number of tokens used for a class}}{\textit{total number of tokens used}}$$

Class	Class distribution											
	Female									Male		
Participants	P1	P2	P4	P5	P7	P8	P9	P10	P11	P3	P6	P12
Surroundings	30	20	20	30	30	20	30	40	30	10	10	10
Infrastructure	40	20	30	30	30	40	30	30	30	10	60	50
Abstract	30	40	40	20	10	20	20	20	30	70	30	20
Interaction	10	10	10	20	30	20	20	10	20	10	00	10

Table 4.10.1: This table shows how widely was each topic represented. In other words, did the participant use many different tokens within a certain class or many tokens?

$$\textit{Extent of use within class} = \frac{\textit{number of themes used}}{\textit{total number of themes within a class}}$$

From the above analysis, we can see that the 'Surrounding', 'Infrastructure', and 'Abstract' themes were equally represented, while the 'Interaction' class was less used. The presented vocabulary was effective, as the majority of it was utilized, and there were very few added themes. The study revealed several intriguing findings regarding gender differences and thematic preferences among participants. Firstly, it was observed that female participants exhibited a broader spectrum of themes compared to their male ones. This could be attributed to various factors, including differing experiences, perspectives, and societal norms.

As the vocabulary was developed based on the outputs in the first study, where a significant proportion of participants were female it's plausible that the vocabulary resonated more strongly with themes relevant to the female experience.

However, despite these variations in thematic range, no noticeable differences were noted in the spoken preferences or the perceived importance of themes. This

Summary of the Class Distribution Table

Surroundings

Participants	All	Female	Male
Mode	30	30	10
Mean	23.3	28	10

Infrastructure

Participants	All	Female	Male
Mode	30	30	–
Mean	33	31	49

Abstract

Participants	All	Female	Male
Mode	20	20	–
Mean	31	28	40

Interaction

Participants	All	Female	Male
Mode	10	10	10
Mean	13	16	7

Table 4.10.2: This table contains mean and mode for all classes in the Class Distribution table Tab Table 4.10.3. It gives the calculations for the whole cohort and per gender.

Class	Extent of themes used within a class											
	Female									Male		
Participants	P1	P2	P4	P5	P7	P8	P9	P10	P11	P3	P6	P12
Surroundings	70	40	40	40	50	40	50	60	60	20	10	30
Infrastructure	70	60	60	50	60	60	50	80	60	20	40	30
Abstract	80	100	90	50	30	50	60	50	80	40	50	10
Interaction	40	60	60	60	80	80	60	60	80	20	00	10

Table 4.10.3: This is the distribution of token use per class and per participant. The use is quite uniform with two participants favoring tokens that describe the infrastructure and one participant

suggests a degree of universality in the significance attributed to certain themes across genders.

An illustrative example of this is that one participant explained that he goes through great pains to cycle in pleasant surroundings and through nature. He takes longer routes and pleasant surroundings is the main consideration when route planning. When I pointed out that this is not evidenced in his map, he answered that the importance of pleasant surroundings was universally understood and did not need to be expressed. This anecdote underscores the shared values and priorities across genders, despite differences in thematic expression. It also, once again, makes us question outputs that are not adequately contextualized and understood.

Overall, these findings shed light on the nuanced interplay between gender, thematic preferences, and perceived importance within the context of the study, highlighting both commonalities and unique perspectives among participants.

Summary of the Extent of Theme Use Table

Surroundings			
Participants	All	Female	Male
Mode	40	40	–
Mean	43	50	20

Infrastructure			
Participants	All	Female	Male
Mode	60	60	–
Mean	53	61	30

Abstract			
Participants	All	Female	Male
Mode	–	–	–
Mean	58	66	33

Interaction			
Participants	All	Female	Male
Mode	30	30	10
Mean	50	64	10

Table 4.10.4: This is the summary of the table Tab Table 4.10.2 for all the cohorts and per gender. It gives the mean and mode per class. In some cases, there is no discernible mode and the mode is not included. In those instances, the mean is the better approximation. However, the absence of mode is telling in itself and implies an uneven distribution.

4.10.2 Augmentations and Additions

One of the motivators for creating ready-drawn tangible tokens was that, generally, people do not feel confident sketching [46]. Tangible tokens aimed to provide them with a core vocabulary that is not definitive or complete. To indicate this, they were invited to expand on what they were given and encouraged to make use of the blank tokens and writing materials. To help them engage with the sketching, at the start of the session, each participant was asked to draw a token for rule-breaking (of their design). Further, the drawings on the tokens were on purpose naive and in some cases badly proportioned (but still recognizable) as it was hoped that this would indicate the fact that any drawing a participant does is not expected to be artistically accomplished. Despite this, participants avoided sketching.

P6:" *So I don't think I am imaginative enough to think of the token for pavement.*"

Out of the twelve participants, nine created a **new token** of any kind. Four participants did not draw but created tokens using writing. In the examples Figure 4.10.3, we can see a drawing (an anxious face) and a written explanation of a barrier to cycling. Three participants drew simple icons, with only one attempting to represent a more complex one Figure 4.10.2. However, it should be noted that this participant created only one complex and the rule-breaking tokens. They augmented nine maps using 158 premade tokens and two they drew them-

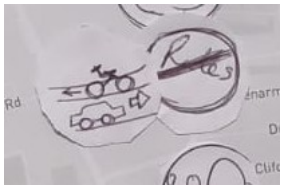


Figure 4.10.2: A token representing a complex situation

selves. All the participants who created tokens by writing on them used them on multiple maps, while participants who drew tokens would create only one. This is not surprising as sketching is a process that is used for ideation, reflection, and notation (to name a few) [130, 46, 317]. Once the sketch is created, the process is finished, and repeating it would be laborious. Writing is something that is done automatically and is less burdensome (for this group of people).

P12: "*I'll just write, it's quicker.*"

Three participants **modified** tokens. The purpose of modifications was to signify the absence of something, to negate something, to classify or to re-purpose. As we can see in the examples Table 4.10.5, negation is used to indicate the opposite of the term, and enhancing the token for safety has been used to amplify its meaning. In this example, the token for safety has been modified with the word "murder" and a sad face to communicate the seriousness of the situation and the strength of the participant's concern.

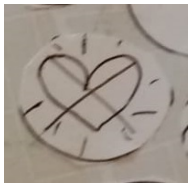
Negation - tokens which are crossed out	
Classification - ordinarily positive-negative.	
Enhancing - reinforces.	

Table 4.10.5: participants modified tokens in three ways. **Negation** to indicate the opposite of what is originally depicted. **Classification** to indicate a class they are assigning to the token. **Enhancing** modifies the token in order to reinforce its meaning.

The study was designed without any mechanism for ranking, or classifying the tokens. This was done to avoid influencing participants towards interpretations. However, some participants wished to communicate attributes like positive and negative, as well as a level of importance. To do this they used colour, double encoding,

reinforcement, writing, and punctuation. In the Table 4.10.5 we can see one example of classification. Only three participants attempted to classify tokens and two implemented classification by drawing straight on the map. Out of these five, one participant explained that the use of different colour is instinctive and without forethought, while another classified only two tokens out of forty-five used. This means that only three participants made a deliberate effort to indicate class in their outputs.

Tokens' meaning was situation-dependent. As an example, Participant One and Participant Eight used *gender-clash* to both describe disagreements they had with their partners and issues they experienced with male cyclists. Participant Eight used *rule-breaking* to mark areas where she feels that she has no choice but to break rules, and also combined it with *gender-clash* to illustrate her husband's different style of cycling with their children.

The most frequent expression device used was a grouping of tokens, combining them into what might be called 'simple sentences'.

In the example Figure 4.10.4 we can see one participant creating a sentence "A good memory of nature " by combining *joy*, *memory* and *trees*, while another has created a sentence "Shared path is a barrier to cycling". The meaning is evident but is also confirmed during the interview. The meaning of the sentences is easier to interpret than tokens in isolation, as they give each other context.

4.10.3 FLOW OF ENGAGEMENT

In order to look at how the materials support narrative creation, I diagrammed each participant's flow of engagement. No participant had exactly the same process (All the diagrams can be found in the subsection .3.1) but some generalities can be extracted. While it is logical that the first map is an introduction (and this was the case across the board), people differed in how they treated maps, and structured their narrative, for the remainder of the story.

Generally, two approaches were observed: one involved combining the maps, while the other was to use separate maps. In the case of separate maps, participants would have a primary map that would carry the main narrative, with transitions to other maps that would be used for tangents or illustrations. An example can be seen in Figure 4.10.5, where the left map presents the main narrative, while the right-hand map serves as a supporting map with less information.

It was common to both approaches that the themes and maps were re-visited as the narrative developed. Participants added tokens to areas they had already discussed as their story developed. The point of the resolution was harder to identify, as participants often continued narrating after making a statement that was either conciliatory (finding a resolution) or summarised their experience (coda). In most of the cases, either coda or resolution was identified but not both. For this study, which is identifying if the visual materials and opportunity to express oneself visually facilitate narration and help experience expression, more nuanced distinction is not necessary. For simplicity, in the final diagram Figure 4.10.6, I am calling both summary and conciliatory statements resolution.

What the diagram shows is that the narrative structure, with all the element,s is present. However, while the starting hypothesis was that a clear narrative structure that is consistent across all the instances would be visible and easily identifiable, that was not the case. Participants did tell a story. These stories were relevant, novel, and comprehensive. They revealed that cycling as an activity is not linear and one-dimensional. Cycling changes and evolves in step with personal development as well as in line with environmental transformations. However, the way these are communicated is as individual as the stories themselves.

4.10.4 Themes from the Narrative Analysis

This study looks at how maps and tangible tokens support narrative expression in active travel discourse and I have performed detailed narrative analysis section 4.6 and structural analysis subsection 4.10.3. In this section, I will look at the themes that the narrative analysis has revealed.

At the start of the study I collected the metadata on the type of cycling habits Table 4.5.1 and the participants' ethnicity and gender Table 4.5.2 as these are the classifications often found in the literature [24, 125, 237, 312, 34].

The metadata did not seem to have a correlation with the themes participants chose to explore. A male mechanic who described himself as a daily commuter (P11), discussed the lack of continuity on a route he takes when supporting cycling at the local school; while a participant who said that only some of her cycling is with children, devoted her session to illustrating challenges her child faces when cycling to a new school. The Table 4.10.6 contains the main theme of their stories.

Upon closer examination of the narratives, certain themes from the first study recur, including the value of cycling for time management, the willingness to opt for longer routes if they are more pleasant, the issue of disjointed links interrupting the flow, conflicts with pedestrians on shared paths, the necessity for wider cycle lanes, concerns about pollution, and the presence of inadequate infrastructure. Additionally, participants also delve into broader themes that have an impact on cycling.

One of them is cycling with children and children cycling independently. Participant Two has discussed, the unsuitability of certain crossings for use by very young cyclists, while Participant Eight has remarked on the attitudes towards family groups (slower cyclists) and the inability of the infrastructure to support them. Participants Eleven and Twelve wanted to draw attention to the lack of connection between areas that are safe for young cyclists and how that limits their, and their families, movements.

Participants Six and Seven remarked on the changes in their environment that are due to social and economic transformation and the way that influences accessibility and any desire to cycle particular sections of the neighborhood.

Participants Three, Four, and Eleven described their commute and some of the changes they experience, and anticipate, due to a shift in their work situation.

Participant Five reflected on the lack of support for people who migrate to London, which is surprising considering that 37% of London's population is born outside the UK [292].

4.11 Conclusion

I have represented here two approaches to analyzing the same data. One is purely qualitative (*narrative analysis*) and looks at context and the other is quantitative and relies on counting. The numerical analysis of the classes and themes representation

P	Survey	Narrative
P1		Cycling important part of her relationship with her partner. Has just moved and doing trial and error to find good routes.
P2		Child started secondary and difficult finding a suitable route. Big bike changed both access (better) and agility (worse).
P3		Cycling to work but avoiding main routes and shared tracks. Exploring cycling as enjoys riding.
P4		Commuting as a journey she enjoys. Concerns for safety but trumped by independence.
P5		Cycling to work and bonding with family. Her journey is affected by changes in her workload and the location.
P6		Cycling as instructor challenging as lack of connections.
P7		Cyclists should be able to choose the direction they travel and this should not be dictated by infrastructure. Orientation of cyclists new to London is overlooked.
P8		Effects of gentrification. Change to spaces that used to be accessible but are not anymore.
P9		Lifetime of cycling in London. A memory tour of the participant's life.
P10		Cycling as a family. Creating social connections through cycling but dealing with animosity
P11		Fun destinations. Choosing to go there rather than having to. Cycling creates a sense of belonging.
P12		Inability to access London when cycling with children.

Table 4.10.6: The list of participants' narratives.

Tabs. Table 4.10.3, Table 4.10.4, Table 4.10.1, Table 4.10.2 gives an overview of the overall use of the tokens and some indication of the engagement with the material but I argue that statistical analysis alone is not fully representative of the cyclists' experience.

Hence, a large part of this study was the narrative analysis of the interviews and maps. While quantitative analysis allows certain insights, it sometimes also omits, or in some cases misrepresents. For example, there are some topics participants discussed at length but they only marked them once or twice, or in one instance

not at all. Participant Six mentioned *rule-breaking* several times but has not put the rule-breaking token onto the maps. Participant Nine also did not put the *rule-breaking* on the map but remarked: "Rule breaking is definitely a feature of cycling in London."

Another example is Participant Twetve who did not use the breadth of tokens representing surroundings but said:

"I can see a token for *nature* but I have not put it as nature is implied. Nature is there."

After I explained that nature is there, as many things are, but being there does not mean that nature is important he said:

"*The nature is always important.*" "*I am one of those people that is willing to double the distance in order to cycle the quiet route. It just affects my mental health.*"

Further, as mentioned in the subsection 4.10.2 token, meaning is interpretative and context-based. For example; same participant used the token **traffic lights** both as 'too many stops' and as 'needs regulation'.

In table Figure 4.10.1 we can see that traffic lights were mentioned by seven participants and were put on the maps only 11 times. This would place them 21st in order of statistical importance. However, they are important factors for the participants who did use them. For Participant One, they are a part of what she calls a "holy trinity" of infrastructure that determines her family's mobility subsection 4.9.1.

Also, I have mentioned context several times already in this study, but cycling is not usually discussed in the context of people's lives. It is usually described in terms of the type of commute [118, 312] or gender [117, 274, 34]. However, how cycling fits into broader themes and changes that happen in our lives, affects our transport decisions. One of the rare works on the subject is Dr Mbabazi's doctoral thesis [202]. A qualitative work that explores factors that shape transport (any transport) decisions of individuals over their lifetime and demonstrates that situational and social events have an effect on our travel choices. I could find no such study looking at cycling specifically and this work aims to fill that gap.

The use of maps as a prompt helped lessen the primacy effect [309]. We can see that in the examples of Participant One, who stated that she wished to talk about the school run to primary school (a journey she completed in only 1/2 hour previously) but once she looked at the map, started describing a different route. Participant Nine remarked:

"*It's a bit like cycling in your mind.*"

In the narrative analysis section 4.7 we can see examples of more confident and less confident participants, and that all of these participants produced a narrative and engaged with the materials. Influence and the effect of token vocabulary can be illustrated with the example of *independence*. Independence was mentioned in Study One by only 28% of participants. In the second study, it was used by 60%. Participant Five did not mention independence until she saw the token, but once she did she expressed its importance to her: "*It (cycling) makes me feel very inde-*

pendent, which is why I keep on doing it, regardless of pedestrians" Having a visual prompt gave participants tools to include important abstract concepts in their expression. As a counter-example, bike repair, which was discussed by 50% of people in the first study, was mentioned by only 30% in the second. The difference might be that bike repair was one of the only cycling-specific prompts in the first study, while the second study had a whole distinct cycling-specific vocabulary.

The combination of maps, token,s and think-aloud has helped capture what these people find important about cycling, how it enhances their lives and how change affects it. Changes in circumstances that influence cycling have been recognized in a study that explored the reasons women stop, and take up cycling again [34]. It is interesting to note that the study also found that the age at which most women stopped cycling is in secondary school, which correlates with experiences related by Participant One in this study subsection 4.9.1. As 23% of the UK population is under 18 [74] the difficulties identified in this study affect almost a quarter of the UK population.

The insights from this study should become part of the larger narrative that is looking at a wider question of cities accommodating the changing needs of cyclists. I believe that finding out people's cycling narrative and how people use the infrastructure can help us understand which kind of cities we need to build. **The use of neutral, icon-free printed maps and vocabulary-based tangible tokens is an accessible and mobile way of identifying main themes and trends. The maps provide spatial anchoring, while the tokens provide prompts and vocabulary.** The full narrative analysis is labor-intensive, especially in the open-ended study and one of the recommendations for future work would be the development of a methodology for narrative extraction that is more tightly bound to the other aspects of the study.

There is a lot of work regarding urban cycling development and the infrastructure [10, 215]. It could be argued that urban planning is not family planning, but urban planning should plan for families. It should also accommodate changes in our lives, like a change of address, career development, and migration. The narrative tells us more than which junction is dangerous and that no one in East London wants to cycle on the towpath. It tells us about people's lives and how cycling fits into those lives, as well as which aspects of their lives do not fit into cycling. It tells us how we need to make cycling bigger in order to accommodate a wider range of people.

4.11.1 LIMITATIONS

It is important to put the conclusions and the processes of this study in context. The whole process, from conceptualization to analysis and conclusions, was performed by one researcher (with generous advice from their supervisor), and thus, unavoidably, to a certain degree, it reflects that researcher's particular worldview and level of understanding.

The situation in which the study was conducted was also limiting as researcher couldn't be present in person to see what the participants were doing and how they

were interacting with the tokens. The plan to ask them to take pictures of the process proved too taxing and overwhelming. Despite the detailed instructions, a participant this approach was piloted on (this individual was not included in the analysis) could not manage to send the images. To mitigate this, the think-aloud methodology was implemented. Limitations with the think-aloud methodology were that participants would forget to report what they were doing or immerse themselves in the task to such a degree that they resented talking.

The materials provided have their own limitations. The maps have set granularity which is inflexible. The creation of vocabulary was, in some cases, limiting as participants resisted expanding it and needed to be prompted to include items from their narrative that weren't already included. This perpetuated anchoring bias [305].

	THEME	NUMBER OF TOKENS
2	Car	74
3	Trees	53
5	Bus	41
6	People	39
7	Other cyclists	38
8	Nature	29
9	Potholes	29
10	Alert	25
11	Hill	23
12	Pedestrians	22
13	Pollution	22
14	Infrastructure	21
15	Confusion	21
16	Independence	19
17	Break in flow	17
18	Memory	15
19	Safety	13
20	Barrier	13
21	Signs	
22	Shops	12
23	Traffic light	11
24	Noise	10
25	Overtaking	10
26	Graffiti	8
27	Music	8
28	Environment	7
29	Wind	7
30	Thinking	6
31	Construction	6
32	No parking	6
33	Weather	5
34	Bike repair	4
35	Gender clash	3
36	Good parking	2

COLOUR ASSIGNMET LEGEND	
	Abstract
	Infrastructure
	Surroundings
	Interaction

	THEME	NO PARTICIPANTS
1	Joy	11
2	Potholes	10
3	Break in flow	10
5	People	10
6	Pedestrians	10
7	Trees	9
8	Nature	9
9	Bus	9
10	Confusion	9
11	Car	8
12	Hill	8
13	Independence	8
14	Pollution	8
15	Alert	8
16	Other cyclists	8
17	Traffic light	7
18	Shops	7
19	Memory	7
20	Infrastructure	7
21	Barrier	6
22	Overtaking	6
23	Music	6
24	Environment	5
25	Safety	5
26	Bike repair	4
27	Noise	4
28	Graffiti	4
29	Wind	4
30	Thinking	4
31	Construction	4
32	Signs	4
33	Weather	3
34	No parking	3

Figure 4.10.1: These two tables show how many times was each tangible token used (the left table) and how many participants have used the token (the right table). The entries are coloured by the class they belong to. The assignment of classes to colours can be seen in the legend on the bottom left.



(a) New token representing anxiety.

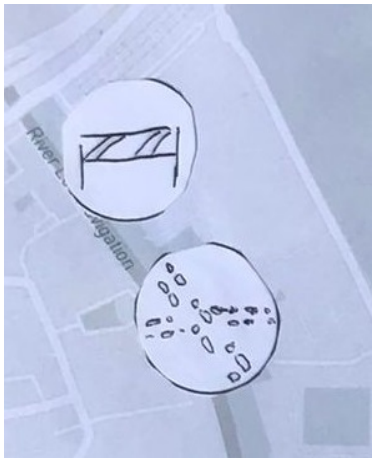


(b) New token explaining a barrier to cycling.

Figure 4.10.3: An example of a drawn and of a written token.



(a) Combining *joy, memory* and *trees.*



(b) Combining *barrier* and *pedestrians*

Figure 4.10.4: Participants grouping tokens to create 'token-sentences'.



(a) Main map carrying most of the narrative.

(b) Caption for figure 2.

Figure 4.10.5: An example of how participants who used multiple maps expressed themselves. They tended to have a small number of maps that carry the narrative and a larger number of maps with less information that would carry fewer points.

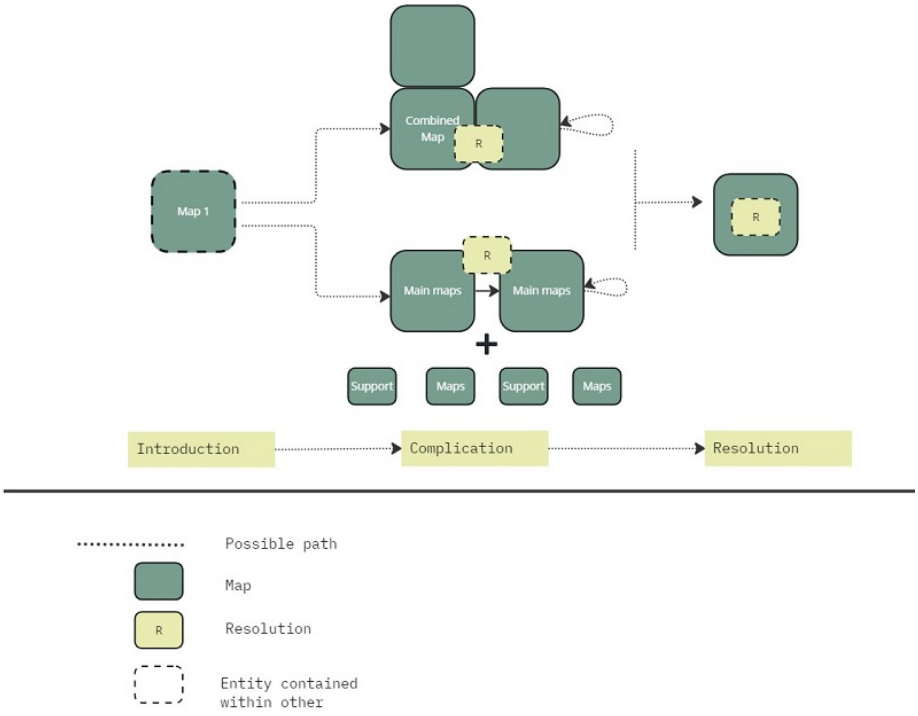


Figure 4.10.6: This is a diagram summarising the relationship between the materials and the narrative. The introduction was centered on the first map, which sometimes became a part of the complication and was revisited. Maps were organized either as a bigger map, or a series of maps that carry the main narrative, supported by other lesser maps. The resolution was sometimes contained within the main maps as the participants would return to the main themes.

CHAPTER 5

CARE OR SELF-CARE ? - INTERACTIVE PERSONALISED VISUALISATION OF LOGGED JOURNEYS



Figure 5.0.1: Stylised representations of participants with icons that relate to their cycling (friendship, social influencers, charity and social participation, fitness, mobility of care and commuting)

For this study, I worked with a small group of ethnic minority women, who kept a diary of their cycling experience and used a GPS tracker to log their cycling over two weeks. The data they collected was presented back to them as an individual data notebook Figure 5.0.2 that contained their activity calendar, maps with the ability to choose a base, visual modelling of all the journeys they have recorded, speed tracking, and the diary prompts. This approach involves exploring the use of logged journeys as elicitation prompts. The **motivation** for this study came from the frustration at the lack of data regarding the mobility of the minority groups. By this, I mean capturing attitudes and experiences of non-white, and especially non-white female individuals who cycle. The search of literature and databases has uncovered a lack of work in this area. London, like many other big cities, is trying to affect a modal

shift in mobility and redesign neighbourhoods in a way that will promote human-powered transport. To effect change in the environment that will benefit the underrepresented groups, we need to learn more about these groups. Female Muslim cyclists were chosen for two reasons. Firstly, anecdotally, they are a subgroup that is the most easily dismissed in conversations as it is assumed that they do not cycle for cultural reasons (both social and practical restrictions such as perceived propriety and suitability of attire). Often researchers do not question their assumptions in these cases out of concern that asking questions will cause a cultural offence. I wished to explore the reality of Muslim women's cycling practices and understand the patterns of mobility within this subgroup through the use of data visualization and maps. I wanted to explore the potential of visualization in this context, recognizing that for a small study, it is impossible to directly follow the women, but maps can provide a canvas to illustrate their movements and experiences My two previous projects were unsuccessful in recruiting participants from these subgroups. Studies one chapter 3 and two chapter 4 have demonstrated that representations of cycling ecologies can produce fresh insights and are effective in engaging participants but also how difficult it is to recruit outside one's own demographic and sphere of knowledge [228].

I mentioned the problem of representation in cycling research during the introduction chapter 1, and this feeds into the questions of self-identification and inclusion. In her work, Criado-Perez [242] shines a light on gender biases present in science and research, as well as their repercussions. Her work covers a wide range of topics, from snow clearing and healthcare, to transport. It shows evidence of biased data collection, which overlooks women and the world that is built based on this biased data. However, gender is not the only basis for stratification [40]. Economic class and ethnicity contribute as much to the segregation. So, one of the aims of this study is not only to provide insight into cyclists' experiences but also for that insight to recognise and embrace cycling diversity. For that purpose, the participants were selected by way of targeted recruitment [101] of women that fall into hard-to-reach groups.

Hard-to-reach groups are defined as [129] ones that are " *...invisible to boards or underrepresented, who use public services but are difficult to engage in public discussion, so their needs aren't heard or considered. There are often minority groups who find it harder to access services, and for whom services may not be suitable, such as people with disabilities, people from non-white ethnic backgrounds, the elderly, and those on lower incomes.*".

When analyzing the increase in cycling participation among minority populations, which also encompasses women, conventional approaches prevail. These methods include quantitative techniques such as counting [117], qualitative surveys [98], and a multifaceted approach exemplified by Lam's book chapter [178], which incorporates elements of literature review, policy document analysis, and insights gleaned from interviews.

An investigation delving into secondary data extracted from representative samples of travel surveys conducted in 19 global cities, [125] explores the impact of

gender on cycling and Active Transportation (AT). It presents findings that women's travel differs from men's in distance, purpose, and number of journeys due to household chores and childcare constraints. Even though generally do an equal amount of active travel as men, they tend to walk more, rather than cycle. The report also finds that in some countries, women are unlikely to make journeys outside their homes, which is due to social expectations and constraints. Despite that, women are overall 5 % more active than men and tend to make more entire journeys using AT, mostly walking. Another finding is that in high-cycling environments, gender differences equalize. In the report, this is attributed to better infrastructure and traffic-related safety. An article [286], which is cited in the above paper, discusses infrastructural and socio-economic factors in Muslim countries that act as a barrier for women cyclists. These are lack of access to bicycles, lack of access to infrastructure, and lack of safety while on the bicycle due to the number of attacks on female cyclists (reported in interviews as there are no government figures). Work by Steinbach et al. [289] recognizes that ethnicity shapes and influences mobility in ways that are subtle and unexplored. In general, scholarly research that encompasses and acknowledges ethnic minority cyclists is notably scarce and difficult to find.

5.1 The Question of Power

If we consider that power is the ability to do something, reflecting on the report that only 27% of cyclists in London are female, the story of cycling becomes one of power dominance and oppression. This significant imbalance prompts contemplation on themes such as gender, identity, and visibility. *Intersectionality* [70] examines the idea that who we are determines what we can do, and in the case of cycling it seems that being a woman predisposes you not to cycle. In their book Data Feminism [91] Klein and D'Ignazio give us guidelines for examining such questions. The steps invite us to examine and challenge power, rethink hierarchies, elevate emotion and embodiment, consider context, and make labour visible. Despite public narratives, many official initiatives and expressed intentions to champion inclusivity and equality of access, whole layers of society have been marginalized and excluded from mainstream institutions, such as education [211]. This omission of presence is echoed across society and Higher Education Statistics Agency (HESA)[5] report data reveals that 85 % of professors working in higher education (academic year 2018/19) identified as white, while only 0.7% identified as black and 0.75% as Asian. One can postulate that this over-representation of white ethnicity in academia might have an impact on research due to the limited scope of the reach and the uniformity of the academic cohort. Academic research is seen as 'ground truth' due to the strength of academic rigour. The inclusion of
textbfHard to reach (HTR) groups is therefore a crucial step towards achieving a more equitable and authentic representation of society. This inclusive approach has the potential to foster more balanced development across all sectors reliant on the insights derived from such research.
"*No one is hard to reach, just more expensive to reach*" is a saying that can be heard

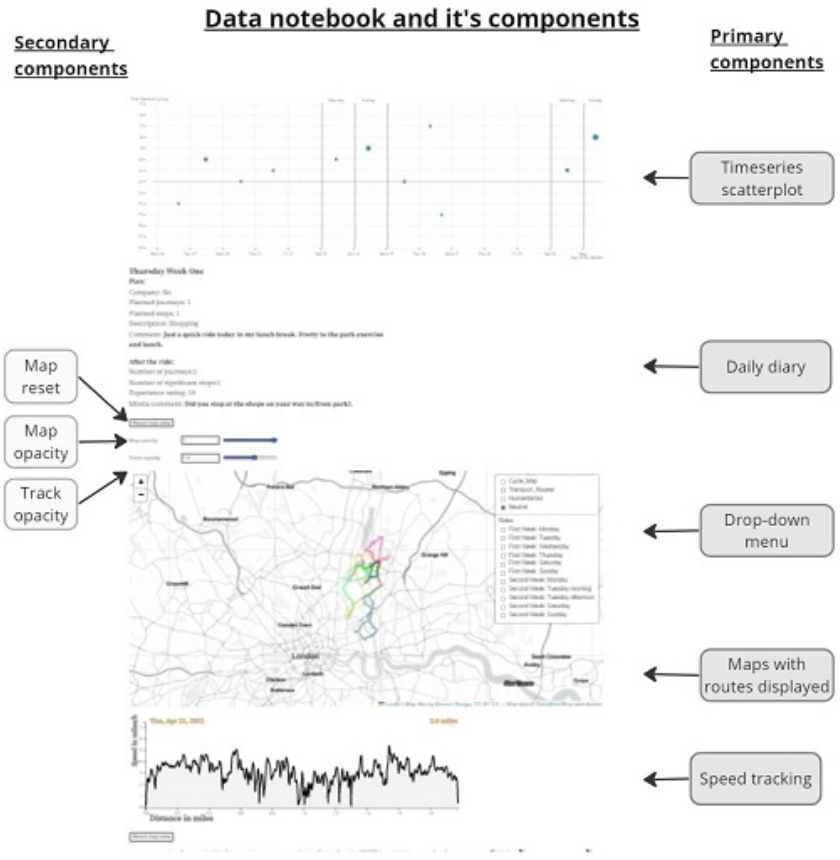


Figure 5.0.2: The data notebook for study three and its components. The main components are a scatter plot representing all their activity over the two weeks, the daily diary prompt, a map with the routes, the drop-down menu, and the speed tracking. The secondary components are the reset button for the maps, the canvas opacity slider, and the track opacity slider.

when discussing the engagement of HTR groups. The barriers to engaging groups and individuals can be due to language, ethnic, cultural, and religious differences, as well as physical barriers such as access to technology, disability, or lack of supporting infrastructure that would allow equal access. While the above quote is true, its meaning is not literal. The biggest cost of engagement is in time and effort. For studies one and two, I devised strategies that I hoped would elicit a diverse response, but failed in some respects. The samples were unbalanced (in favour of female cyclists with an average of 70% female participants), and lacked economic and ethnic diversity. Recruiting cross-culturally and across different economic strata is challenging. In Occa et al. [228] investigations of recruiting underrepresented cohorts have shown that contact is increased between similar people and that it is helpful to engage in culturally appropriate communication and activities with potential participants. This reflects my own impressions and findings from the first two stud-

ies. Even when I was not physically visible as a white woman (such as in recruiting leaflets), my language and phrasing resonated with people who resembled me, and I was mostly successful in recruiting white, educated female participants. There was a disconnect between my intentions and outcomes which might have to do with a lack of trust and connection.

The next section describes the steps I took to ensure participation of the hard-to-reach cycling cohort; in this case ethnic minority women cyclists.

5.2 RECRUITMENT

We have established that women comprise only 27% of cyclists in London [109], out of that number, BAME women are an even smaller percentage. Reaching such a small and dispersed subgroup is a difficult challenge for someone without direct involvement. In the instances where minority advocacy groups are active, they can provide a gateway and a mediation for sensitive access and considered research through the application of targeted sampling [101].

In the case of female cyclists in London, there are a couple of Women Cycling GroupsWCGs) with largely Muslim membership. They are independent and non-profit organisations supported by TfL and the local government. I approached one organization and was invited to join the rides and train as a ride leader to get to know the women better. Hence, the recruitment was done mainly from a social support group of the WCG I worked with, but was not confined to it, as the aim was to engage with minority women that cycle wherever they come from. Due to the logistical constraints of time and practicalities (each participant would be tracked for two weeks and there were only two devices), it was decided to recruit six participants. This was later expanded to seven due to a special case of two novice riders forming a friendship through the group and both volunteering to participate. Both participated, but their data was looked at individually. The name of the organisations I collaborated with, the names of the participants, and some minor details regarding the participants have been changed, and proxies used to preserve anonymity.

5.3 IMAGERY IN MUSLIM SOCIETY

A close representation of human beings is forbidden in the Quran and Muslim religious literature. Places of worship do not have depictions of people, Muslim saints, or The Prophet himself. This knowledge raised a question of what boundaries need to be imposed, and conventions observed when creating a visualization-based workshop for the members of the Muslim community.

My aim was to track the movement and create a representation of it. I needed to make sure that this was not synonymous with capturing and modelling a person as forbidden in the scripture. The examination of existent literature has not revealed

any work that examines the Muslim community's relationship with concepts such as signage icons or emojis. However, Muslim Society of Britain provided some valuable guidance for working with individuals of Muslim faith [230]. Their own efforts to examine public domain demographic data on the prevalence of Muslim faith in the UK [229] has proven a useful guide, as the summary visualization is an info-graphic which contains icons of human figures Figure 5.3.1.

To further clarify the matter I engaged friends and colleagues who observe Muslim faith in conversation regarding this topic and discussed the matter with the WCG CEO. I was assured that data visualization does not come under the constraints outlined in the Quran,

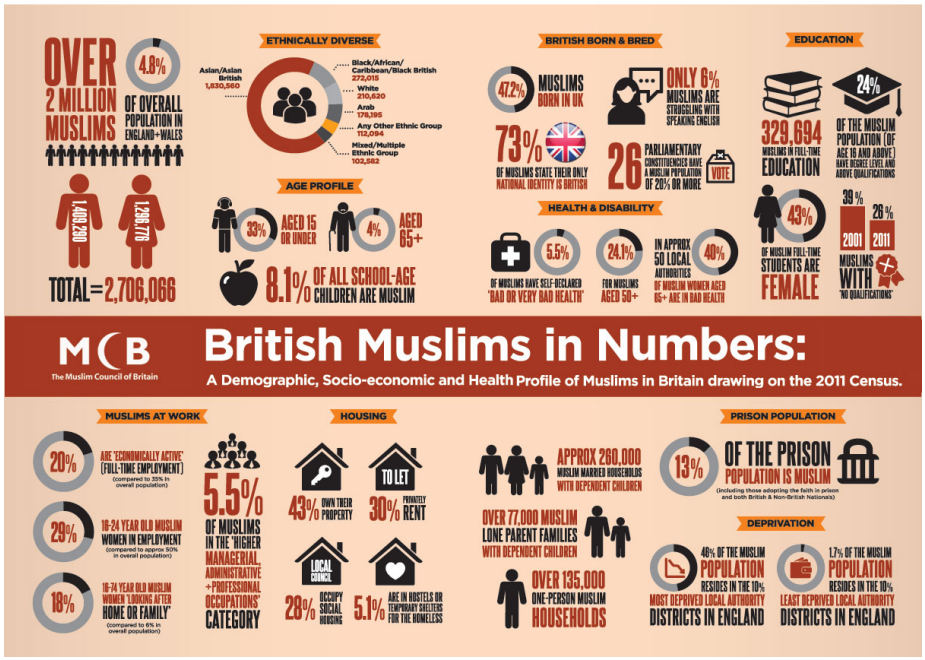


Figure 5.3.1: The info-graphic used in the demographic analysis by the Muslim Society of Britain.

5.4 METHOD - THE DATA NOTEBOOK

In Study One for some participants, paper maps presented a challenge. Participant Seven did not want to engage with maps and remarked that they only use maps on their device, and even then rarely. Participant Twelve expressed a strong preference for digital maps over paper. Participants nine, eleven, and four commented that they missed the ability to zoom in without looking for a map (nine attempted to emulate this by connecting two maps at different scales). In Study Two, transporting, storing and conducting remote sessions remotely while using physical materials meant that observing the participant's interaction with the materials was impossible. During the design phase for Study Two, a pilot exploring the use of digital was run section 4.1 but the specific tool used proved too challenging to use. part of the problem was in the nature of the task presented. Augmentation and visual modification, such as drawing on the screen with the mouse is imprecise and requires mapping of movement from the horizontal surface to vertical presentation [100], thus increasing mental load. For the Third Study, I wanted to create something that is portable, has ability to change the scale of representation and location.

Both notebooks and dashboards are commonly used tools in data-driven fields. They are used to explore, analyze, and communicate data, but have different characteristics and use cases. Dashboards are visual displays of data that provide a high-level overview of key metrics and observations in a concise and interactive format. Dashboards are often used to monitor performance, track progress, and communicate insights to stakeholders [239]. Dashboards are typically created using specialized tools or platforms, such as Tableau, Power BI, and D3.js, and can include various visualizations, such as charts, graphs, and maps, arranged in a layout for easy consumption. They are particularly suitable for presentations and corporate analysis as they allow high-level overview [3], but can be seen as inflexible and do not allow direct access to data [3].

Notebooks are interactive computing environments that allow users to create and run code snippets, interspersed with explanatory text and visualizations. They have an advantage over dashboards in that they allow multiple processes in a single environment [3]. They allow the creation of branching narratives and notebooks with dependencies [328]. Collaborative data platform Observable [39] is built as an artistic program, which is an environment in which multiple languages can be mixed with desired selections and transformations of code segments [297].

The choice of Observable for this project has enabled the creation of an ecosystem of co-dependent and branching pages that enabled data wrangling and custom presentation while allowing control of the processes in a reactive environment.

5.4.1 THE DATA COLLECTION

These days every app store contains a comprehensive range of cycling and navigation mobile applications. Some of the more popular ones are Kamoot and Strava. However, despite the increase in mobile phone ownership, the use of an app is exclu-

sionary, in that it would prevent individuals without smartphones from taking part. Also, there is an issue of some of the applications not working on all mobile platforms, or having different functionalities depending on the platform used. Further, while platforms claim that they do not sell data and are General Data Protection Legislation (GDPR) compliant, people are concerned for their privacy [330, 131, 137]. Some studies develop their own applications [295, 33] as this can guarantee greater privacy and a tighter data curating process. However, this comes with a great time and technical cost and also might be exclusionary for some users as these applications tend to be tightly coupled with a single operating system.

An alternative to the mobile applications is a cycling computer that passively collects participants' movement data. When using the cycling computer, the participants are in charge of which movements are recorded and which are not. After careful comparison, we chose the Elemnt Bolt tracker for ease of use and length of battery life. The device collected the longitude, latitude and time, and stored it in the .fit file, which needs to be converted into a format suitable for exploration in a coding environment. The GPS Visualiser [266] is an online tool and mapping resource aimed at supporting map developers to migrate between different file types, thus simplifying data management. It offers data conversion, field extrapolation (such as speed and distance) tool integration (Leaflet, Google Maps), tutorials, and the visualization of data. I used GPS Visualiser to convert the raw data from .fit file format to .gpx which was more suitable for use in the chosen coding environment.

The Kalman smoothing algorithm was used to minimize the 'noise' in the data, as it was found to give results that are most stable and have the highest fidelity when compared with vehicle on-board measuring systems [58, 337].

5.4.2 SURVEY-DIARY

A diary is used in qualitative and mixed-method data collection as a primary source and in combination with other data collection methods [133]. In Active Travel and cycling, diaries tend to be used in conjunction with GPS tracking [134, 222] for contextualizing collected data and as an analysis aid. In addition to these applications of a daily diary, in this study a diary also served as a memory jogger.

As the data collection lasted two weeks for each participant, the diary needed to be of a size and complexity that was consumable and would not take too much of the participant's time. The original intention was to devise a diary that would engage in the manner of a cultural probe [119], however, as the participants already needed to manage the GPS device, it was decided to prioritize convenience. Also, the pilot for the first study demonstrated people's reluctance to engage with unsupervised tasks (participants were instructed to send additional data, reflections or feedback on pre-addressed, stamped, postcards, which was highly unsuccessful). Hence, two short surveys were created; one was to capture cycling intention (morning surveys regarding cycling plans for the day) and the other was to capture the realization of this intention (end-of-the-day report). The reasoning behind this was that it would capture barriers that are not anticipated (journeys planned but not done) and also

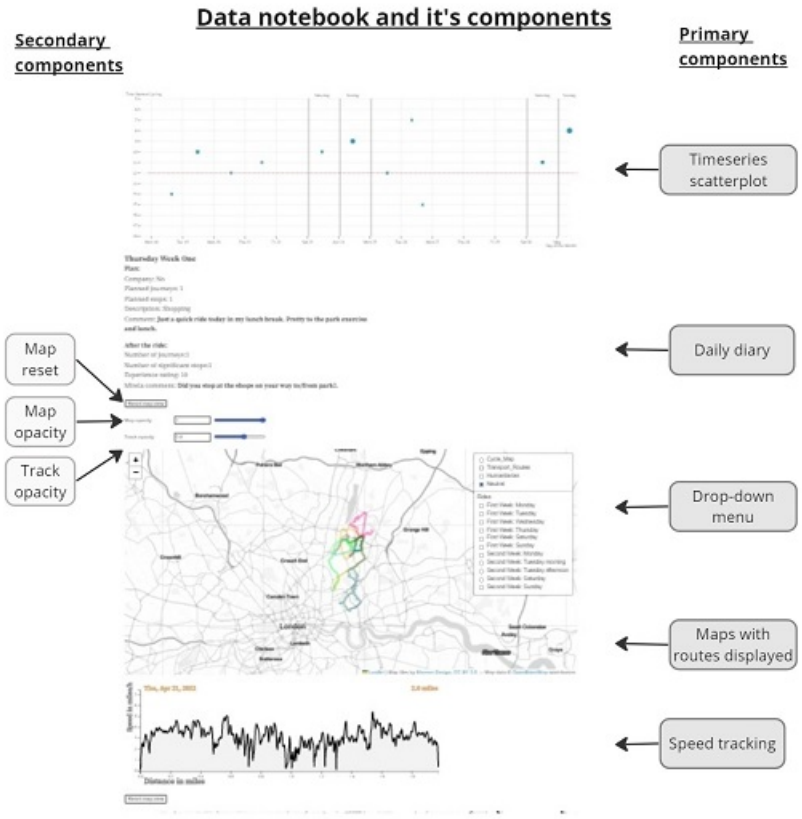


Figure 5.4.1: Screenshot of the data notebook with annotations as to primary and secondary components. The screenshot is truncated as it does not include the second map and the second temporal scatter plot, which are present in the data notebook and visible on the wireframe Figure 5.5.5. Primary components are visualizations and the diary, while secondary components are sliders for adjusting opacity and the reset button

uncover how cycling facilitates spontaneous decisions (unplanned but realized journeys). To capture trip chaining, which is considered as a behaviour attributed of female cyclists [280, 254] and the mobilities of care, the participants were asked to record the number of significant stops they were planning to make/made. For the first survey diary of the day (intent to cycle), they were also asked if they were planning to cycle in the company, to give a journey category (type), and to add a memory jogger comment. The evening survey diary had only three questions which asked for the number of journeys completed, the number of significant stops, and the experience rating. During the pilot for the study, it became evident that despite the simplicity, completing the diary is a challenge because people forget it needs to be done, so every participant was sent a reminder twice a day.

5.5 The Design and Map Choices

The design for the data notebook needed to situate people's digital records in a way that would foster recollection, and encourage exploration. The design needed to capture subjects' behaviour in space and time and incorporate qualitative elements captured through the diary survey.

For contextualising of the rides, participants were provided with a choice of base maps. As seen, in the first study chapter 3 the map content has an influence on what the subject chooses to express. In the first study, we saw examples of 'map-riding' behaviour where participants re-drew the same journey on maps with different attributes.

The mapping resources and tools I chose to utilize are, Open Street Map [57] (OSM) collaborative project, mapbox [196] development environment and Leaflet.js [4] open-source library for creating the maps. OSM and Leaflet.js have gained popularity for a number of reasons. Namely, their collaborative nature fosters a feeling of ownership in the community, while the open source Open Source (OS) status provides free and unlimited access. mapbox, on the other hand, has gained popularity due to the intuitive nature of the interface, its versatility and a wide range of integration. Between them they offer a comprehensive range of base maps and options for modifications. While mapbox is a commercial enterprise, OSM and Leaflet.js library are both open-source and free to use. Their development relies on donations from the community and the effort of many volunteers who contribute content and help with providing fixes when issues arise [181, 93, 321]. Despite the openness of OSM, and the equality of opportunity, content creation is not balanced. [73] shows that because the software development and mapping is male-dominated, content creation for OSM is also male-dominated and that men and women contribute different types of content. Some of their findings are that pubs and sports venues outnumber childcare providers and playgrounds.

When creating the interface I observed the following design considerations:

- **User Needs in the Light of the Study Goal** - Participants needed to be able to see the journeys in a variety of ways (individually and in the context of one

another) and to place those journeys spatially and temporally.

- **Ease of Use** - The interface needed to be intuitive and easy to navigate for participants of all levels of digital confidence.
- **Visual Clarity and Accessibility** - The interface needed to be structured in a way that facilitated clear visualisation of data, with clear elements and sections.
- **Scalability and Performance** - The interface needed to be flexible and scalable to effectively present varying amounts of data and journey scale.
-

Here, I am presenting the final result of what was a fluid, iterative and organic process of development akin to Agile Methodology in software development. This means that there wasn't one, or two hard designs that could be discussed independently, but rather a series of adjustments and tweaks that grew around the central feature (map with the journey displayed).

THE MAPS

In the data notebook, I limited the number of maps participants could use for two reasons. The first is that it reflects the more limited selection made by many of the participants in Study One chapter 3, and the second is not to overwhelm the participants and to enable clear analysis. The maps have been chosen on the basis of the information they provide and their visual characteristics.

I have taken into account three categories of map attributes when choosing the maps.

1. **Information that it relates** - all the maps differ in the aspect of the geographies they capture as well as their complexity. This is increasing from the Stamen Light map (this map will also be referred to as 'neutral' in the following text as it does not contain icons) to the OSM Cycle map (which tries to capture cycle-specific features, urban attributes as well as road pedestrian relevant content). Each map offers a different environment. Stamen Light provides freedom from distraction. The Transport map offers connections to the public transport infrastructure that might serve as a reminder or a locator. The Humanitarian map contains local resources and municipalities. The Cycle map presents the classification of the roads and cycle-friendly features.
2. **Visual Clutter** - This is a combination of the previous features, as the clutter can be calculated in a number of ways (as a number of distinct objects, number of contrasting hues, number of vertices in an image etc.). Visual clutter is important for this task, as the number of features can have an influence on segmenting a scene and performing a visual search [262]. Ultimately, visual clutter is subjective and difficult to determine for the interactive maps due to

personal preferences and the variety of locations that might be examined by participants. It also changes depending on the scale.

Based on these criteria, I have chosen the following maps:

Maps and their features		
Map	**Information**	**Clutter**
Stamen Light	Roads, road names, natural features, area names	Monochrome colour palette and no icons - low clutter.
Transport OSM	Roads, road names, natural features, area names, public transport routes, and stops	Neutral background with a strong contrasting colour for the bus routes. One item (bus routes) draws attention - low clutter.
Humanitarian OSM	Roads, road names, natural features, area names, icons for local resources and transport.	Harmonised colour scheme in terms of saturation. Icons draw attention but are not in high contrast - medium clutter.
Cycle OSM	Roads, road names, natural features, area names, icons for cycling resources, and colour classification of roads.	Icon-rich map with contrasting colours and many items that draw attention - high clutter.

Table 5.5.1: Maps used in the third study and their features..

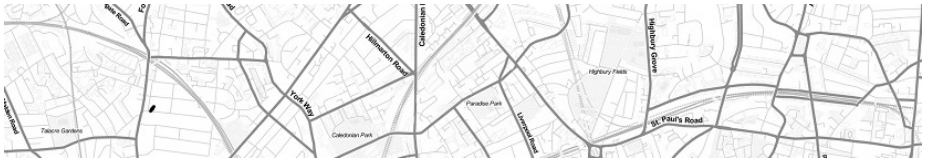


Figure 5.5.1: A section of Stamen Light map

Stamen Light Toner [85] **Stamen map**s are produced by a design studio with a focus on map making and visualization. Stamen maps are known to be both aesthetically pleasing and highly informative.

Stamen maps offer a range of base maps, including Terrain maps, Watercolour maps, and Toner maps. Toner maps are black-and-white maps, which are ideal for overlaying data and visualizations.

Stamen maps are commonly used in a variety of web applications, including data visualizations. They are also popular with designers and developers due to the quality of their designs and the accessibility of the materials. Their work is intertwined with the work of Open Source Map (OSM) [321].



Figure 5.5.2: Transport map

Transport map [234]

OSM transport map is a type of map that is designed to show transportation features and information using data from Open Source Map (OSM). It focuses on displaying information related to transportation infrastructure, such as roads, highways, railways, and public transportation systems like buses and subways.

This map is important as many cyclists follow public transport routes. Anecdotal evidence implies this is especially true of new cyclists who have transitioned from using public transport to cycling. Also, in the first study, participants used the sighting of buses and rail/tube stations as landmarks. Lastly, the second study demonstrated the significance buses have, as the bus token was the fourth most used Figure 4.10.1. Buses can be a cause of friction despite, or maybe due to, buses and cyclists being assigned to the same lane at many locations. Hence a transport map captures an important landscape for cyclists.



Figure 5.5.3: Humaniterian map

Humanitarian map [299] is created for the purpose of aiding humanitarian efforts and disaster response. It is used by organizations such as the Red Cross, Doctors Without Borders, and the United Nations in emergency situations to help coordinate and direct relief efforts.

The OSM Humanitarian map is designed to be a detailed and accurate map, with an emphasis on identifying important infrastructure and resources, such as hospitals, schools, water sources, and transportation routes. The map is created and updated by volunteers from around the world, who use satellite imagery and other sources to add information to the map in real-time [300]. It is an important tool for improving the effectiveness and efficiency of humanitarian efforts and disaster response. It was specifically designed by its creators so that the features and colours are light enough to be drawn on if the map is printed for use "offline" in areas with no electricity.

The muted colour scheme and local features make this a good background both for displaying the tracks and for the orientation.



Figure 5.5.4: Cycle map.

OSM Cycle Map On the surface, this should be the best map for eliciting the motivations and lived cycling narrative, as its content is cycle-centric. However, study one has chapter 3, section 3.9 shown that the types of cycling infrastructure highlighted on this map may not represent the kinds of features that resonate with participants' experience or that they find safe. Cycle lanes, as well as features like cycle parking, are clearly marked on this map and A-roads and high roads are highlighted. It has cycle-specific icons, such as bike repair, which was mentioned with great frequency in the first study, water stations, cycle furniture and even rain shelters. However, it is the map with the highest visual clutter, strongest hues and largest contrasts. It is important to note that our definition of clutter differs from the way it is defined by Longley et al. [186], which states that clutter is the presence of "ex-

cessive" detail. In this work no judgement is made on the choice of content and its usefulness for the intended audience. Clutter refers to the visual appearance of maps and the number of features competing for the participant's attention.

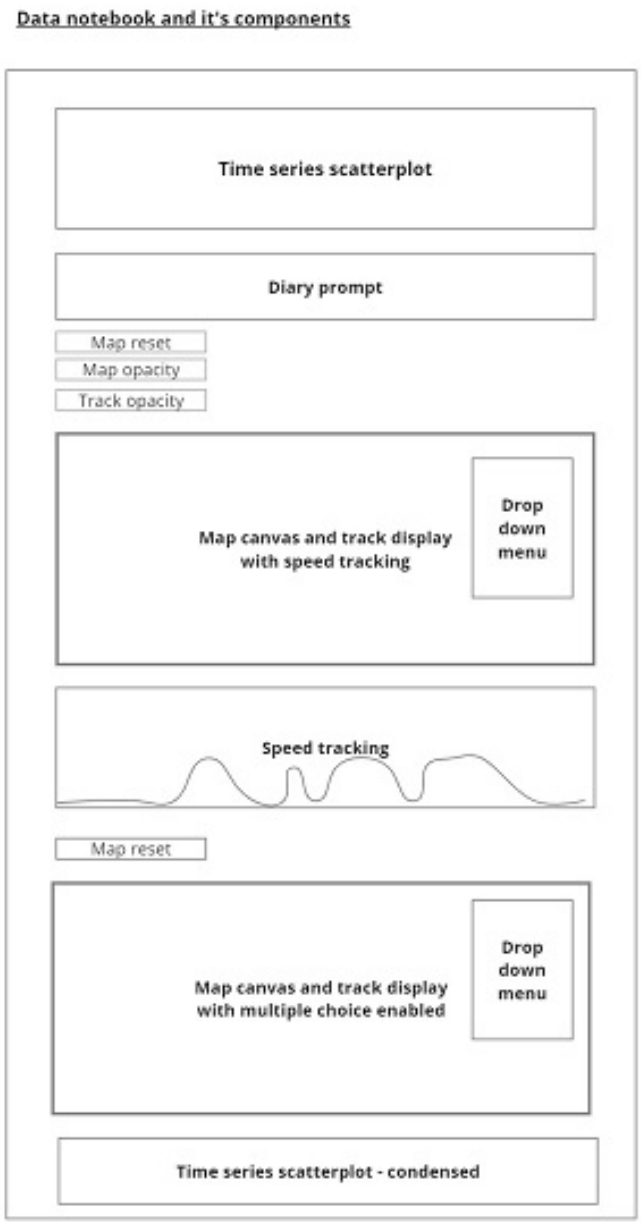


Figure 5.5.5: Wireframe for the study three data notebook.

5.5.1 THE VISUALIZATION OF FREQUENCY AND CYCLING TRENDS

The visualization and analysis of individual cycling efforts are scarce in research. However, one example of channelling personal participation in cycling events through visualization is Wood [324]. They created designs which "focus on representing the aspects of participation that evoke an emotional response in an effort to engage users" through minimalist cartographic design, position charts, and animations of rider density. While allowing personal focus by inputting individual textual narratives to 3D variations in terrain, the rider is part of a cohort, and performance comparison is part of the process. More examples of visualizing personal cycling data can be found in the open-access notebooks on the Observable collaborative data platform and canvas [227]. They are scarce and tend to be created by individuals who have high involvement with sporting activities over longer periods. Hence, extracting metrics such as total time per activity, total distance per time period, pace per activity, and time allocation of activities, is meaningful and insightful. My task is to create a memory jogger, which will enable deeper insights that relate to the environment and attitude to cycling for a group of individuals with diverse cycling habits.

The first visualisation in the notebook is a time series scatter plot, representing the time and duration of all the recorded rides over the two-week period. This was created in the hope that it would help participants discern trends, as well as aid recollection. Data used for the time series scatter plot were dates and times of the recorded rides. The dates were in UTC date format and were used to extract attributes such as duration, time of day, and day of the week. The data manipulation and the visualization were made using Observable.js.[227]. The resulting scatter plot has dates on the x-axis, and the times, in hours, on the y-axis. For each journey, the starting time, together with the date, was used to position the circles. The magnitude was used to convey the duration of the journeys. Hence the radius of the circles corresponds to the cycling time in minutes. To aid the orientation, I inserted a 'noon line' in a contrasting colour to the items of the scatter plot, and marked the weekend visually and with text. The plot was a headlight component for a feature-rich notebook. While designing it, care was taken to follow the Edward Tufte principles of 'maximum information per ink ratio that promotes comparison and relationships'. In line with the principles, the background is a neutral colour, and while there is a grid in order to support orientation, it is executed in a light colour, which is non-dominant. The x and y axes are clearly labelled and spaced to improve readability. The visualization has one textured, dominantly coloured guideline, and accented and labelled weekends. The date and time are encoded with position and the length of the recording with the magnitude of the circles.

I produced two versions of the chart with two different y-axes. One showed all of the hours between 5/am and 22.00pm (assumed waking hours) Figure 5.5.6, while the second version is truncated and shows only the instances that the participant spent cycling Figure 5.5.7. Strictly following the Tufte principles would favour the truncated version as it minimizes the white space. This raises the question if the white space is unnecessary. One might argue that the white space is an encoding of

the day's magnitude and an aid to reading the visualization, as with the truncated version, there is an extra step of needing to read the y-axis labels to understand the positioning.



Figure 5.5.6: The scatter plot of cycling activity per day, with the duration with the adjusted y-axis.

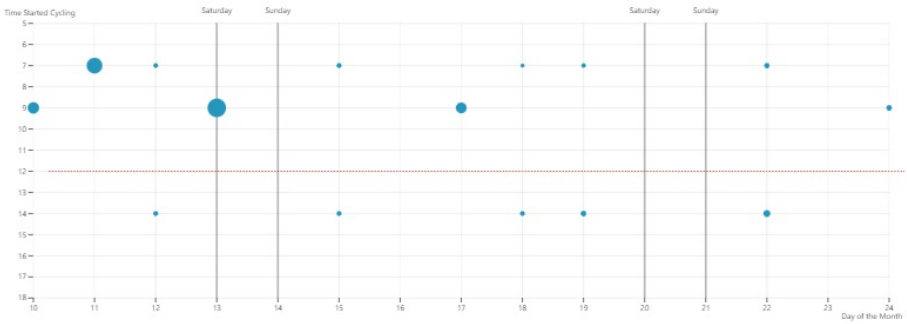


Figure 5.5.7: The scatter plot of cycling activity per day, with the full y-axis.

Both versions of the chart were used in the data notebook. Each was positioned in close proximity to maps, as an excessive need for scrolling leads to disengagement [104]. The full y-axis map was displayed above the top map and the truncated version was below the second map. This design was decided upon as the full version is a stand-alone entity that can be used as a reference for the diary section above and the map below, while the truncated version is placed below the second map, hence echoing the first map design that couples a map with a chart below Figure 5.5.5.

5.5.2 Speed Tracking

Cycling speed tracking is usually done for performance tracking and comparison [67, 103], while the number of stops cyclists make has been measured to contextualize the interaction of cyclists with other road users [37]. A work by Parajito et al. uses speed to calculate friction. They combine speed and geo-location to identify friction locations and their characteristics in the three European cities [237].

As the participants in this study are women, identifying stops can indicate the trip chaining [280] behaviour that is associated with female mobility. In order to enable participants to recognize and identify the stops, they were asked to record making significant stops in the daily diary; but also, their speed was plotted on a line chart, which was positioned below the map Figure 5.5.8. An interactive feature

was implemented which enabled cross-filtering [320, 249], in that selecting a point on the speed line chart would show a corresponding location on the route map. The top map contains two additional markers, which are a green and a red circle. The green marks the start of the recording and the red circle marks the end Figure 5.5.8.

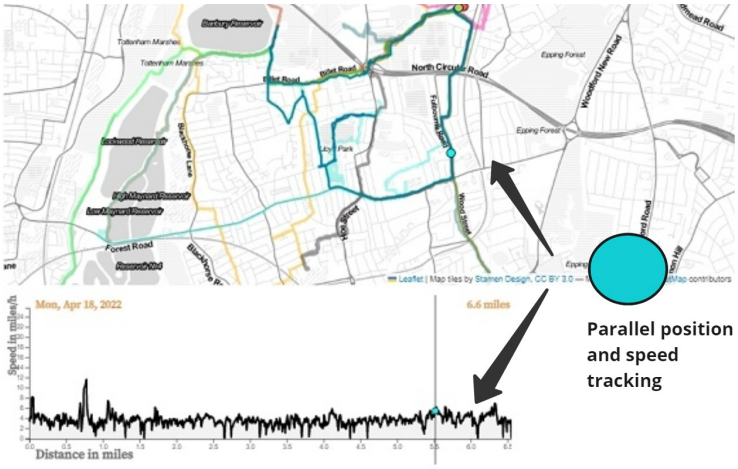
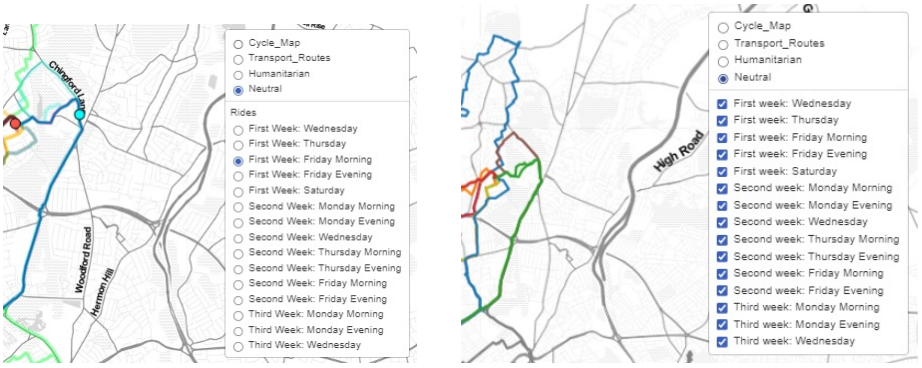


Figure 5.5.8: The map displayed the route taken and the line chart displayed the speed. The participants were able to relate position with the speed by moving the mouse along the line chart. This displayed as a blue circle and moved a corresponding circle on the map. The blue circle above the text in this image is a magnified version of the circles used and it is present in this image only for illustration purposes.

5.5.3 Layers control

The map sections in the data notebook integrate multiple tile layers and GPS data to provide a visual representation of the participant's journey and geographic information. The system not only includes base maps but also overlays multiple GPS routes onto them. These routes represent cycle rides participants have made and chosen to record during the two-week period. Each captured route consists of a series of points with latitude and longitude coordinates, along with additional metadata such as time stamps, speed, and direction.

The GPS routes were displayed on top of the map layers, providing information about the location and movement. Users had manual control [162] of the map and the GPS routes, in that they could zoom in and out, pan around, and toggle between different layers. As can be seen in the wireframe Figure 5.5.5, there are two cells containing maps, each providing a different way of displaying routes. Both have a selection option implemented by a drop-down list with layers control, that is divided into two sections. The top section in both areas enables base map choice (the available maps are described in the section 5.5) by use of radio buttons. The difference is in the bottom section. This contains a list of days and the week in which the ride was recorded. In the first area, participants chose individual rides by clicking on the relevant radio button Figure 5.5.9a. The selection highlights the chosen route and its starting and finishing points. The selection also makes a call to the list of diary



(a) Radio buttons for individual selection.

(b) Checkbox buttons for multiple selections.

entries and the relevant entry displays above the map. Also, the associated speed line chart displays below and links up to the highlighted route.

In the second area, the participants were presented with the same list of rides, but with checkbox options Figure 5.5.9b, that enabled them to select, and display, multiple rides.

Both representations have automated reset buttons, which re-centre the maps. The top section also has two sliders; one to adjust the opacity of the non-highlighted journeys and the second to enable the isolating of rides from the map and the obscuring of geographic prompts. Opacity adjustment is used to ensure there is no occlusion, for filtering, and for dynamically exploring datasets [245].

5.6 Methodology for Analysis

The analysis of the third study examines the content of the interviews plus the actions and interactions with the data notebook.

The analysis adopts a two-pronged approach. Firstly, to address the adequacy of visualization provision and its role in insight elicitation. Secondly, to reveal the cycling realities of this small group. The visualization and the subject's interaction with its various components will be analyzed using **thematic analysis** [41] that helps identify themes and uncover patterns. Originally, the approach that was considered was **interaction analysis** [162] which is a method primarily developed for working with recorded content. Its origins lie in ethnographic research and social studies. In its original form, interaction analysis is performed by research groups, and group discussion and collaboration are at its core.Thus, even modifying the approach was deemed too distant from its original form, given that the analysis was conducted by a single researcher; hence, thematic analysis was chosen instead. The themes were extracted using the following process:

- Initial watching or recordings for initial theme framework.

- Extraction of the transcript and re-watching of the videos to re-visit the codes.
- Re-examination of codes in regard to different participants in order to extract generalities and trends.
- Use of NVivo qualitative software to collate and finalize the codes.

The analysis was an iterative process where the recordings were re-watched accompanied by transcripts in order to identify and isolate the common themes. NVivo software was used to support the process.

5.7 Running the Study

5.7.1 The Pilot

There are different methods of project planning, with the two most common being the waterfall method and agile development. The waterfall method is linear and more rigid as it does not allow for any mistakes or oversights at the planning stage. The *agile approach* on the other hand, takes into account that there might be a difference between planning the project and its implementation [205]. In my work. I have adopted the agile methodology and tested each component upon completion, as well as run the pilot study.

For the first two studies, I was physically present during the entirety of sessions and could offer assistance and clarifications at any point. However, for the raw data collection stage of the Third Study, I could only communicate with participants remotely. Hence, it was important that all the necessary testing was done in preparation. Once all the components were developed and tested by me, I asked a member of the WCG, to participate in the trial run. The pilot subject completed all the preparatory surveys and recorded their cycling journeys for seven days. The pilot participant (PP) helped identify which aspects needed to be rephrased and helped solidify the flow of the process. The positive findings were that there were no issues with the hardware and that the surveys took less than a minute to complete. Also, the reminders were essential, as although the PP would record the rides without prompting, the surveys were not filled in unless a prompt was sent.

5.7.2 Launching the Study

Following the pilot, and after obtaining ethics approval, the study was launched by posting a call for participants on the two social network threads used by WCG and their sister organizations. These are distinct groups that collaborate on projects and share membership. WCG advertise their rides on the Eventbrite platform, while the sister organisation only posts rides on their closed group chat, which is hosted on the WhatsApp social platform. WCG WhatsApp group has 184 members, while the sister organisation has 123. These are the members who have been added over four

years of the groups being active. The recruitment of new members is done primarily by word of mouth. As both groups rely on social platforms for communication, posting the invitation for participation there was the most logical course of action. Furthermore, witnessing the communication processes while participating in WCG activities, made it evident that the phone was going to be the primary method of correspondence for this project. This premise was confirmed during the pilot by the tester, who expressed a strong preference for phone communication over email. Furthermore, emails are used for communication in 'White-collar work jobs but are less used in 'Blue-collar work' jobs and for stay-at-home parents. As discussed in the section 5.1 [228], it is important to align communication methods with the participant's norm.

The launch of the study generated an instant response and several individuals expressed their willingness to take part. Some volunteers were not suitable for the study due to the fact that they did not fall into the desired demographic. Six participants were recruited from the WCG and from the sister organisation. The last two participants had a unique story, in that one was a cycling beginner in that they just learned to cycle, while the other was returning to cycling. They struck up a friendship during organized rides and had been cycling together on a weekly basis. They both volunteered to take part, and the planned number of participants was expanded to accommodate them, as they brought valuable individual insights and a parallel narrative. For all participants, their names were changed to preserve anonymity and avoid dehumanization; therefore, pseudonyms were assigned.

5.8 THE PARTICIPANTS

All the participants were currently, or historically, involved with WCG or their sister organisation. As there were no constraints on cycling ability, the cohort contained cycling advocates as well as novice cyclists. Five of the participants identify as Muslim and two are of Black heritage. Four out of seven participants have children. All of the participants were employed, with four having full-time jobs, two having part-time positions, and one self-employed individual. In the continuation of this section, I will give a short description of each participant.

PARTICIPANT 1 - KENDA

Kenda is in her forties and works as a social worker. She is married, but they have decided not to have children. She is a competent but not confident cyclist. She cycles early mornings for fitness and for joy. She loves being next to trees and nature and avoids busy times when cycling by herself. She does not engage in utility cycling or vary her route as finding a new route is a mental challenge. She also cycles at weekends with her partner and goes on longer rides with him. The partner is a daily cyclist. They have set routes and favour tracks that are less crowded.

"I like going out early in the morning. It is a chance to exercise, it is quiet, also,

there is a forest as well. I just like looking at the trees and listening to the birds, a sense of serenity. Also, there is no traffic. ”

PARTICIPANT 2 - AMIRA

Amira is an avid cyclist, and cycling is an important part of her life. She is working full-time and is the head of a large family. Cycling provides her with personal space. It is her time for reflection and independence from daily tasks (motherhood, employment). There is also a social aspect, as she is a cycling advocate, but this is of secondary importance. She has an interesting attitude towards cycling infrastructure. Long stretches are more difficult than the diverse experiences of dealing with traffic, or using side streets, as she finds safe monotony mentally dulling. Despite having children, she cycles with them very rarely and does not use the bike for utility tasks or care journeys. Nor does she do any trip-chaining.

“If I had to change the job and it was closer to home, I would leave half an hour early to give myself time to cycle.”

PARTICIPANT 3- RAMA

Rama is in her thirties and in full-time employment. She lives with her parent, for whom she keeps house, and is close to her siblings and their families. She is a cycling influencer and is very active on social media. Even though she learned to cycle as a child, she is new to regular cycling and only started cycling as an adult after the COVID-19 lockdowns, when her brother gave her a bicycle. She is cycling through Ramadan, which is unusual. Other participants were careful to avoid doing the study during Ramadan, partly to avoid cycling while fasting, and partly because their time was taken up with other Ramadan-related activities. Rama’s participation in the study was disrupted for several months (due to injury), which resulted in a significant time gap between the routes being recorded and the interview session. As her habits changed in the meantime, she found it challenging to engage with the notebook. During the two weeks of data collection, she commuted to and from work, with very little variation. By the time we met for the interview, she was much more active and adventurous with her cycling. The tracking did not capture the social bonding rides she does, such as her weekly outings with nieces and nephews, or her half-shopping trips (where she cycles to the shop, buys things and her father comes in the car to collect them). In the two weeks, there was one instance of trip-chaining where she cycled to work, from work to a local shop, and then to the gym before going home. Since the cycling activity recording, she has joined several organizations she goes on rides with. This has increased her confidence and now she often sets out on solo adventures, sometimes without any other plan than to enjoy riding a bike.

She loves a challenge, and going home sometimes takes a different route that is longer and has more traffic, to get more exercise. Her cycling has changed and,

“I just love exploring, going here, there, and everywhere.”

PARTICIPANT 4- DESA

Desa is also a cycling advocate. She is self-employed and is a mother to three young adults. She is also a carer for an elderly relative. She is an active cyclist and active in the community. She is a ride leader for a WCG and also takes part in organized rides that fundraise for charity. The recording she did for the study includes training rides and an actual charity ride. She owns two bikes - a road bike, and a utility bike which she uses for visiting local shops. Besides cycling for community engagement and utility, she also does solo trips for well-being and cycle outings with friends and family. She recorded eleven rides, out of which, two were utility, three were solo self-care, three were community engagement and three were social bonding.

PARTICIPANT 5 - ZEINA

Zeina is a young mother who works part-time as a nursery manager. She does a lot of care journeys and trip-chaining on most days. She did more cycling during the study than she does usually. This resulted in her cycling more after the study was complete. She cycled on eight days and did trip-chaining on six. She made spontaneous trips on four.

PARTICIPANT 6 - NELLA

Nella is a single mother of a grown child, and she works full-time for the local authority. She is also a returning cyclist who learned how to cycle in her youth but has never cycled regularly. She purchased a bike during the lockdown but used it on only a few occasions. After the lockdown, she signed up for WCG and met Thea. They exchanged numbers and have been riding together ever since. This has increased her confidence and she has started to go on the well-being rides by herself (as well as doing some utility rides). In two weeks she recorded cycling for ten days. She is very spontaneous and adventurous. Her rides are often longer than planned, and to places she has not visited previously. This resulted in them being difficult to recollect (but a lot of fun). She did no trip-chaining and no explicit care journeys.

PARTICIPANT 7 - THEA

Thea is a novice cyclist. She is a single woman in her late forties who learned to ride through a local authority scheme and has built her confidence by taking part in WCG' beginner rides. She only cycles for social bonding and well-being. She does not cycle by herself and does not use a bicycle for utility, commuting, or care. "I always cycle in the company." She recorded rides on five days, with all the rides lasting over two hours.

5.9 Summary Analysis

5.9.1 Interaction with the data notebook

The study and the data notebook were originally conceived as fully interactive, with participants engaging with the content independently. However, due to circumstances that were a consequence of the COVID-19 crisis, the university's facilities were inaccessible and there was no other secure controlled space for running the sessions. The project and meetings with the participants required compromise and flexibility. The meetings took place in public venues such as cafes and in some instances parks. The strength of the internet connection, as well as the level of comfort and ease of the participants, limited the quality of interaction. Also, for consistency, all sessions needed to be on the same device, which was a City, University of London laptop (unfamiliar to participants). Hence all the participants expressed reluctance to manipulate the dashboards themselves, and instead, the chauffeured interaction method was used [326, 87], where participants instruct with prompts.

5.9.2 Observations on Participant Interaction

The participant level of engagement varied in the number of recorded journeys and the level of engagement with the data notebook. The number of journeys ranged from five to seventeen (morning and evening commute makes for two journeys a day). Likewise, the interview length varied from 25 min to 80 min. The high number of recorded journeys did not map to the length of the interview. In the Figure 5.9.1 we can see that the average time spent per journey discussed, contrasted with the number of journeys the participant addressed. We can see that Thea discussed only five journeys, but her average time was 12 min. On the other hand, Rama, a participant with the most journeys recorded, spent an average of 3 min per recorded track. We can also see that two participants who were new to cycling had the longest per-journey discussion. In the Figure 5.9.2 we can see how participants interacted with the notebooks. While there are no obvious patterns, as participants' use was in response to the journeys they made, we can see that some journey explorations involved a variety of notebook elements.

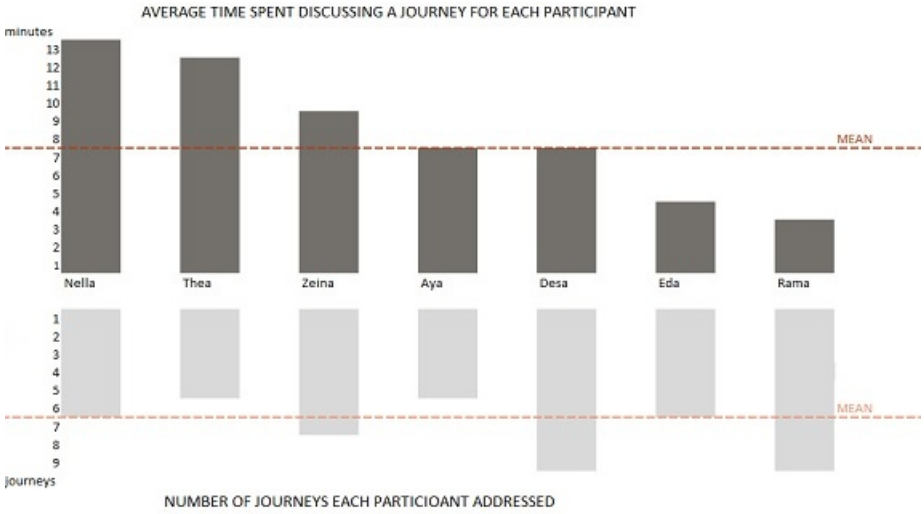


Figure 5.9.1: Average discussion time per journey and the number of journeys discussed per participant.

The two participants with short interviews shared some journey characteristics. Most of their journeys were repeat journeys with little variation. This representation gives us some further insights. Only Rama, the cycling social-media influencer, chose the cycling map as the first map. For the rest of the participants, it was not the immediate choice, and Nella said "It gives me too much detail". Cycle map has the highest number of labels and salient features. As we can see in the Figure 5.9.3, at the same zoom level, the cycling map has twice as many salient features [63] and labels as humanitarian and transport maps, and four times as many features as the Neutral map. However, all the participants, except Amira, used it further along in the interview. Amira is a very active cyclist who commutes, cycles for pleasure, is a ride leader, as well as a volunteer cycling instructor. Her journeys were local, and she knew the area, the roads, and the environment. Her map of choice was the Humanitarian map. It was a map she could relate to more (*This looks a bit more familiar* and on which the green areas are more distinct than on the other three maps. Figure 5.9.3 Amira has also said that parks and green areas are how she triangulates herself in space. Further, despite the familiarity with the area, the icons on the Humanitarian map served as a signpost in situations where a diary was not enough of a reminder. In the Figure 5.9.2 we can also see that the participants alternate between prompts to extract insight.

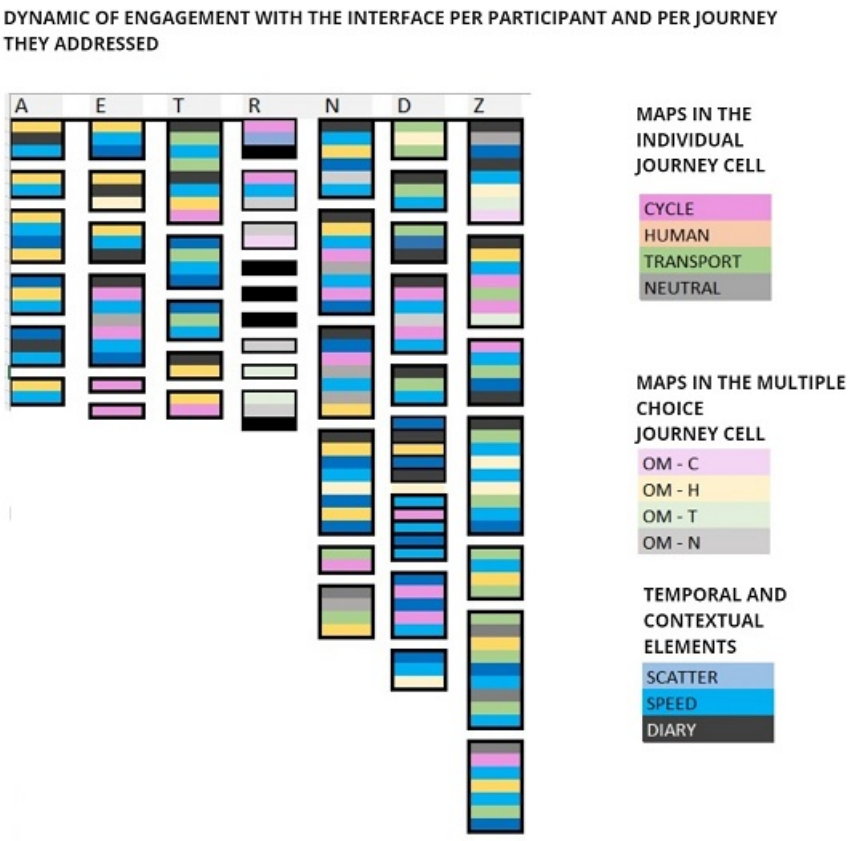


Figure 5.9.2: Dynamics of engagement per journey and per participant. Each column is one participant and each block is one journey they discussed. The legend on the right gives us encoding for the elements of the data notebook.

When examining the less frequent journeys or weekend outings, participants looked for clear labeling at the lower zoom. In the Figure 5.9.3 we can see that, at the same zoom level, the humanitarian and transport maps contain fewer labels than the cycle and Neutral maps. Further, the labels on the Humanitarian map do not stand out, and the labels on the Transport map seem to be clustered around the transport paths. As mentioned, in some situations a Transport map provided insight by revealing a busy bus route (Nella), and a Cycle map helped connect sections of travel. In the Figure 5.9.4 we can see the type of information each of the representations provided. It is the view Zeina has when trying to remember a section of her day. She rotated through the maps and we can see that in this instance the Humanitarian map had the relevant prompt Figure 5.9.4b.

In the Table 5.9.1 we can see the aggregate number of use for each feature over all sessions. It shows that the journey tracking option (choosing a single journey which is highlighted) was used far more than the simultaneous display of multiple journeys. This aligns with the aggregate of supporting visualizations and features use,

Frequency of map use				
	Humanitarian	Cycle	Transport	Neutral
Journey tracking	23	21	21	7
Multichoice	2	3	4	3

Supporting features use		
Speed	Diary	Scatterplot
40	31	26

Table 5.9.1: This table is in two sections. The top section contains aggregate numbers for map use by type and by notebook map cell (single journey representation with tracking or comparison). We can see that participants used the single journey option more, and that the Humanitarian map was the most popular, while neutral was the least. The second section gives us an aggregate of the supporting features used. Speed tracking was the most used feature.

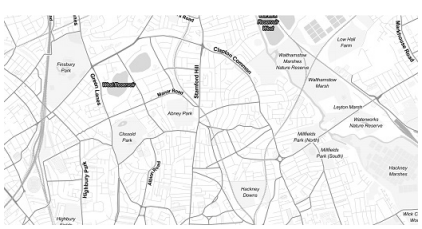
as the most used feature was the *speed tracking*, which is linked with the first cell. The Humanitarian map was used most frequently, with cycle and transport being used an equal number of times. The Neutral map was used the least. The Neautral Map has the least features but it is clearly labeled as we can see in the Figure 5.9.4 and Figure 5.9.3. This seems to imply the importance of clearly representing general markers, such as green spaces, and providing relevant and relatable prompts for the interactions where maps are used to elicit information.

The multi-choice option was used in two scenarios. The first was when participants wished to see separate tracks made on the same stretch or road. The Kalman smoothing [58] was used on all tracks but a higher level of noise was allowed on tracks that were not selected for examination by cross-filtering [320], as the selected tracks needed to allow smooth progression of the tracking marker. In the case where one recording consisted of multiple laps, the smoothed opaque tracks caused occlusion [245]. We can see an example of Kenda's laps where the individual tracks are not very clear in the Figure 5.9.6a, but much easier to distinguish in the Figure 5.9.6b. We should also note that in cases where there was a single track on the route that participants would frequently take, a combination of noise and opacity enabled detection of the use frequency Figure 5.9.5.

The second scenario was where participants recorded more than one journey in a day. This was particularly for journeys to and from one destination where they wanted to see all the day's movements in one place This scenario was used more frequently, as 90% of participants expressed a preference for circular journeys Table 5.9.4. We can see an example of such a journey in Figure 5.9.7 (the representation is truncated, and the start and endpoint are removed to eliminate the possibility of identifying the participant).

Of the supporting features, speed tracking was used the most frequently, Table 5.9.1 and the temporal scatterplot the least. As the data collection period was brief, it was unlikely that any unknown patterns would be found, but the temporal placing of the rides and ride length encoding in the magnitude of the circles, was useful for orientation.

The participants referenced the diary frequently, but the references participants recorded were often not informative. "Oh, excellent, I said something that helps



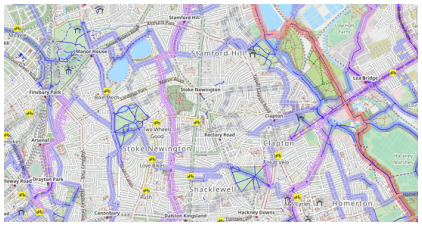
(a) Neutral map. 21 labels and 4 salient features.



(b) Transport map. 16 labels and 6 salient features.

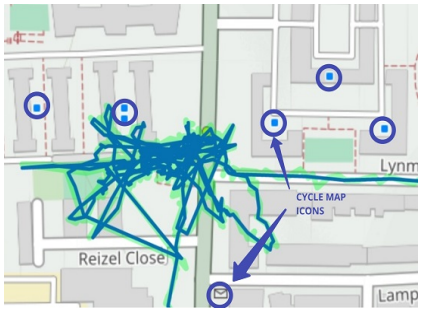


(c) Humanitarian map. 15 labels and 8 salient features.

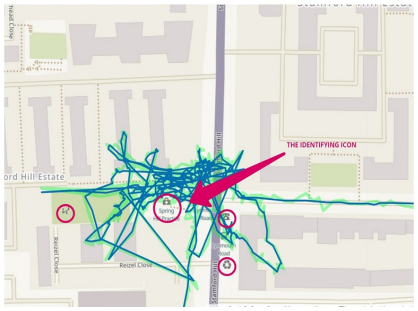


(d) Cycle map. 39 labels and 16 salient features.

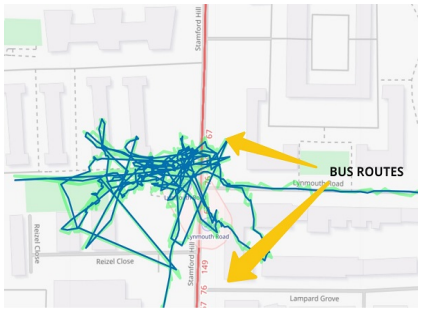
Figure 5.9.3: We can see here a representation of the same geographical space, at the same zoom level, on four maps. The maps differ in the number of labels and the number of salient features. The Humanitarian map has the least number of labels (15) and the Neutral map has the least number of salient features (7). Cycle map has the highest number of labels (39) and the highest number of salient features (16).



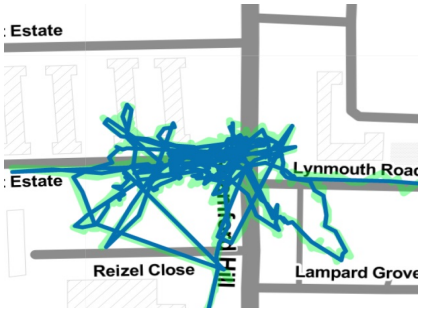
(a) Cycle map with icons for cycle parking and letterbox.



(b) Humanitarian map with icons or human resources.



(c) Transport map with public transport routes and services clearly marked.



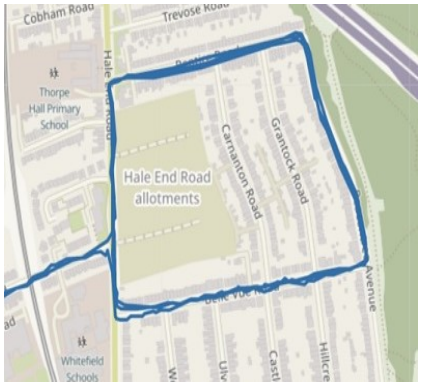
(d) Neutral map containing names of the roads.

Figure 5.9.4: Four base maps at maximum zoom. This example illustrates different aspects of the same geographical area that each map provides. In the image (b), we can see an arrow pointing to an icon that acted as a memory jogger for one of the participants. In this case, the Humanitarian map was the one with the right information.

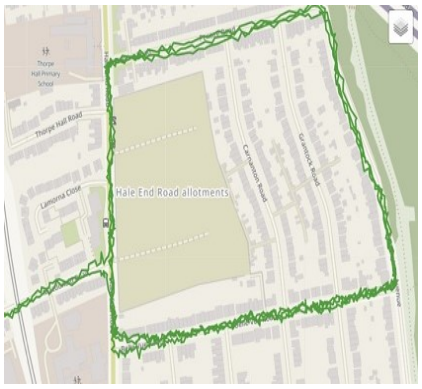
finally." The feedback from participants was that the daily survey diary was not a burden and that they would have been happy to devote a little bit more time to it. Out of five participants who made spontaneous journeys, the diary captured journeys made by three. The fourth participant who made spontaneous journeys was not making them at the time of the recording, as her cycling habits have evolved since; and the fifth one incorporated them into her daily cycling so they were revealed in the description during the interview but not in the diary. Out of three, only one mentioned an unplanned trip without the diary prompt, which shows the value of separating the recordings of intention vs actual journey.



Figure 5.9.5: The recorded tracks are opaque, hence preventing occlusion and allowing identification of high-frequency paths.



(a) The track detail in the single-journey cell.



(b) The track detail in the multiple choice cell.

Figure 5.9.6: The depiction in the single journey cell is smoothed using the Kalman filter to facilitate easy tracking by participants. The track in the multiple choice cell has a higher level of noise, which allows for better segregation of individual laps.

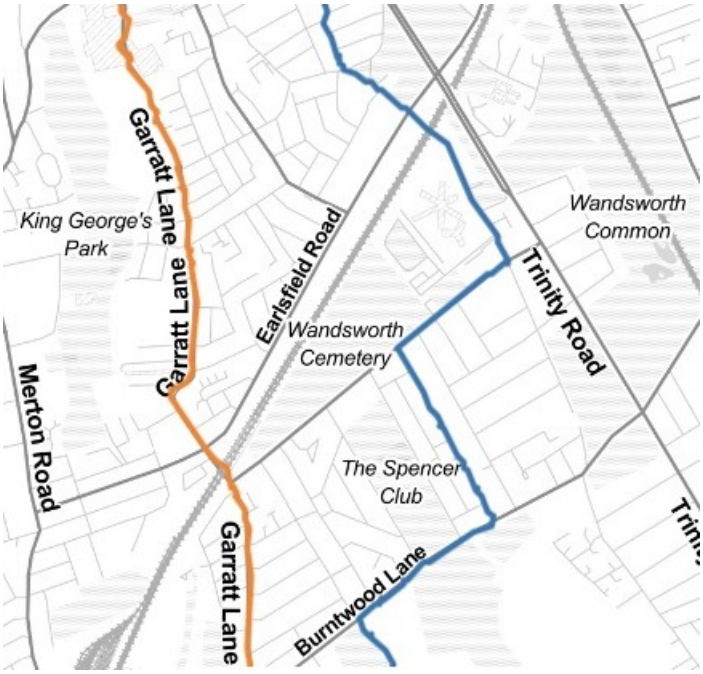


Figure 5.9.7: Example of use multi-choice cell use. The participant has recorded outgoing and returning journeys separately but wished to examine them in combination. (The start points and the destination are not being shown for confidentiality reasons.)

5.9.3 Cycling Habits

As can be seen from the section 5.8, the cohort was small but diverse in terms of cycling proficiency Table 5.9.2, work commitments, and family structure.

Cycling proficiency	Number of participants
Intermediate	4
Experienced/advocate	2
Beginner	1

Table 5.9.2: This table breaks down the cycling proficiency of the participants. Most participants can be classed as intermediate, with two cycling advocates and beginners.

Despite the said differences, there were some commonalities in the motivators for cycling. I have determined the frequency of a specific type of journey by considering the total count of participants who engaged in it, as opposed to calculating the frequency on an individual participant basis. Six out of seven participants engaged in cycling for well-being Table 5.9.3. These are trips that they took for fitness, recreation, and for mental health. In this category are included journeys that have other primary purposes but have been extended or modified to promote wellness. The examples are: Rama took a longer (and busier) route home in order to extend her cycling time, and Amira would both take longer routes and make detours to parks

for solitude and respite. The only participant who did not make any well-being rides, or modify any journeys for the purpose of well-being, was Zeina, who almost exclusively did journeys of care.

Five out of seven participants made journeys that fall into the category of social bonding. These are journeys that were made either with organized social groups or with friends and family. This number comes with a caveat, in that Rama has not made any, but in the interview, she revealed that the tracking was done during the period before she found organizations to join (although she was searching for groups at the time), and that the weekend weather was unsuitable for her usual ride with nieces and nephews. Also, this number does not include multiple rides that Zeina did with her small children, which are recorded in her diary as cycling alone. While there is inevitable bonding when we spend time with people, those journeys were journeys of care as they were school runs and commuting to activities.

Three of the participants rode bikes as part of a community engagement. Here there is an overlap with social bonding, as leading organized rides falls into both categories. For two out of three participants who did community engagement activities, the activities were not cycling-related. As in, two participants cycled to community engagement that was not cycle related.

The least frequent types of journeys were utility (such as shopping), commuting, and care. Care tasks are different from small shopping trips as it is difficult to separate participants' own needs from the care of others in this situation. Examples of care trips are school runs, chemist collections, and any other appointments or tasks that are done for other people.

Activity	Total
Well-being	6
Social bonding	5
Community engagement	3
Utility	2
Commute	2
Care	2

Table 5.9.3: This table shows which type of cycling participants engaged in. All, bar one, participants cycled for well-being and only two used bicycles for utility, care, or commuting.

5.9.4 FURTHER THEMES

The thematic analysis of the interviews uncovered further themes that were not related to motivations and cycling purposes (as motivations were acknowledged in the ride classification Table 5.9.3, they are not included in this section of the thematic analysis). Some of the additional themes uncovered were expressed by a definite sub-section of the cohort. The themes split aligns with the cycling competency Table 5.9.2. In the Table 5.9.4 we can see that the most frequent overarching themes are *independence, fear of attack*, and the *preference for circular routes*. There is a strong inclination towards *early-morning rides*, and most of the participants have

commented on the *flexibility afforded by cycling*. While this list contains the most common themes, there is an exception, as the *preference for side roads* is included despite being explicitly mentioned by only two participants. It merited inclusion because it directly addresses a point often raised in literature [138, 24, 178], which is women's preference for side roads. This is largely attributed to women being more risk-averse and having less confidence on high-traffic roads. In this study, of the two participants who mentioned the preference for side roads, one was an experienced cycling advocate and the second a novice cyclist. The sentiment they expressed was that they prefer side roads to good infrastructure, which implies that the preference is not due to safety concerns. When asked for a reason, Amira said that good infrastructure is often monotonous. She feels that it requires higher mental effort and is hence more tiring. It is often long straight stretches with little variation. Thea answered the same question by saying that side roads are just nicer and more pleasant. However, this might be because Thea is still very new to cycling and prefers to avoid proximity to motorized vehicles.

Universal Themes	Total
Independence	6
Documenting rides	6
Safety from attack	5
Preference for circular route	5
Flexibility	4
Preference for early mornings	4
The preference for side roads	2

Table 5.9.4: A table of general themes for study three. The most common theme is fear of attack while on the bicycle and preference for circular routes.

However, there are a few themes that occurred only in interviews with the intermediate and beginner riders Table 5.9.5. The most frequent one is *the effect and impact of organized rides*. Some participants benefited from them recently, some were searching for rides as none were active in their area. Kenda cycles the same route in laps most mornings. It gives her joy and is an important part of her routine. The route she uses was shown to her by a member of WCG who has since left, and there are no members or rides in the vicinity of where she lives. One might speculate that this has inhibited her reconciliation with the surroundings as she has not elaborated on the route she was shown a couple of years ago. She is one of the participants engaging in non-peak-time cycling. Non-peak-time cycling is when beginner and non-confident cyclists take advantage of the quiet times, such as early morning and weekends, to familiarise themselves with, or just engage with, their environment. The other strategy used is exploration. This is a trial-and-error tactic for finding preferable and suitable routes. As established in Studies One and Two, a lack of signage is an issue for all cyclists and a barrier for people new to London, or new to cycling in London. The less experienced cyclists in this study more often opted for longer routes regardless of time pressure. As an illustration, Zeina, Nella, and Thea would routinely take longer routes the majority of the time, while an experienced

cyclist Amira could tell the day's weather by looking at what route she took, as on the nice days she would go around for the enjoyment of it but on the rainy days, she would take a straight route to keep dry. Lastly, we have *cycling wisdom/experience*. This can be safe routes, appropriate bikes, cycle buying schemes, and repair places with good locks to keep your bike safe. This is the knowledge that can be transformative for new cyclists. Nella said: "*I got a good lock now, which means I can lock my bike places. It has opened up a whole new lot of possibilities.*"

Intermediate and Beginner Themes	**Total**
The effect of organized rides	4
Non-peak time cycling	3
Exploration	3
Longer safer	2
Cycling expertise	2

Table 5.9.5: A table of themes specific to intermediate and beginner cyclists. They acknowledge the importance of having a supporting social infrastructure. They use exploration and cycling in non-peak times to acclimatize to the environment. They use exploration to re-learn their environment and will go a longer route if they consider it safer. There is also a need to acquire cycling expertise.

5.10 LIMITATIONS AND BARRIERS

Due to complications that were the result of the COVID-19 restrictions, meetings took place in public settings, such as cafes and parks. These settings did not always have optimal Wi-Fi connection and setting up was a challenge. Further, as the study did not rely on the participants owning a device, they needed to use my laptop, which they were not familiar with and did not want to use. This meant that in most of the cases, I co-piloted the interface for them and they only engaged by proxy.

Further, due to unexpected circumstances, there was a pause of a couple of months, which meant that for one of the participants, the recordings did not reflect her current cycling habits.

5.11 DISCUSSION

Data notebooks are at the forefront of GIS and are used to create reproducible and scalable analytics [331]. Tools like Jupyter Notebooks, R-markdown, and Observable enable combining software code, output, explanatory text, and diverse media resources in one document [244]. Data notebooks incorporating GIS are used in economics, biology, and astronomy, to name but a few [244]. The academic use of notebooks in active travel is in its infancy. Examples such as Sin [180] implementation of a routing algorithm and Zhenlong's analysis of the origin-destination flows [184] are some of the instances of the emerging work. Notebooks are popular with Strava [290] users and several works on performance metrics analysis have been published on Observable [78]. For this study, the notebook provided a canvas

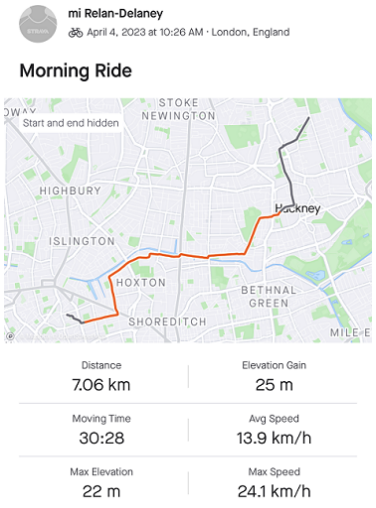
for the integration of multimodal personal data. Notebooks supported the structure on which operations could be performed. These operations can be manual or automated [318]. Manual operations were interaction with the drop-down list (radio and check buttons for base map and route choice), scale adjustment using zoom, attribute opacity adjustment, hover (temporal scatterplot tooltip), and speed filtering. The automated functions were cross-filtering of speed and position, as well as map position and zoom reset button. These enabled attribute manipulation, selection, and adaption of the interface to participants' needs and tasks. In geospatial visualization, it is impossible to include all the information about the area and any attempt to do so might result in clutter [261]. Generalization is an abstraction of attributes in a way that best suits the map's purpose [162]. An example of generalization is the Transport map, where icons are only present near the transport network lines and nodes. The level of abstraction and detail varies in the four maps that were used. Abstraction detail is also dependent on the magnification level. In the label and salient features comparison Figure 5.9.3, we can see that the Neutral map has a higher number of labels but e Table 5.9.1 it is the least used representation out of all four. This is despite six out of seven participants remarking that the feature they are looking for is clear labeling. That the participants favored maps with more saliency over the clear labeling supports anchor hypothesis [61] which states that " primary nodes or reference points anchor distinct regions in cognitive space". This phrase refers to how our understanding of different concepts or ideas is organized in our minds. It suggests that certain key concepts, often referred to as "primary nodes" or "reference points," serve as anchors for different regions within our cognitive space, which is the mental framework where we store and categorize information. These primary nodes act as key reference points that help us navigate and make sense of related ideas or information within our mental framework. While labeling is important, it is not granular or informative enough to contextualize cyclists. It provides "*space*" in the "space and place" [153][14], while the icons provide the "*place*.

The cycling map is the representation with the highest visual clutter [262], [96], [261]. Calculating visual clutter can be challenging when it comes to maps. They tend to contain a high level of detail which varies depending on the location. For this study, the represented area contained a diversity of regions, such as residential, industrial, and nature. Salient features were representations of attributes such as icons, different classes of roads (defined by colour or texture), and types of land. The higher the number of salient features and labels, the higher the clutter. An approach that counts the number of hues and their contrast was considered, but defining the colour and saturation categories proved to be challenging. The Cycling map had the highest number of salient features and labels, as well as having labeling redundancy, in that some geographic areas were labeled twice. Hence, only one participant chose it as the first map, but its contextual value, in that it contains activity-specific features, meant that the majority of participants used it frequently (only Amira did not use it all). In fact, we can see that the Humanitarian, Cycle, and Transport maps are used in mostly equal measures.

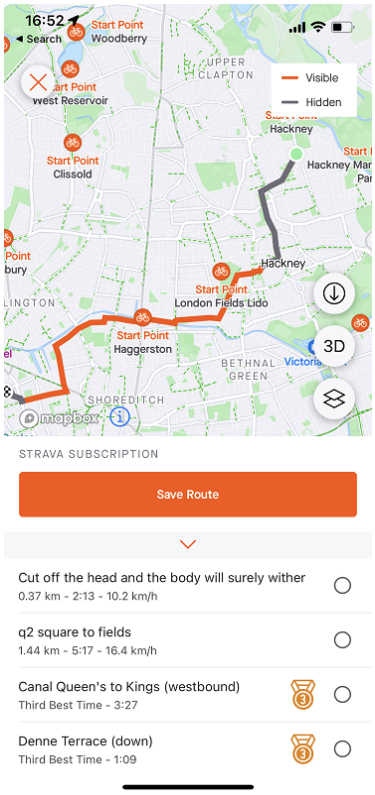
A work by Rzeszewaski and Kotus [263] examined the general usability and accuracy of online participatory planning, using participatory mapping tools. They

used a mixture of participant monitoring, feature counting and eye tracking. Their findings were that the platform was generally well-received by users, but users of all ages fail to perform even simple tasks accurately and have issues in orienting themselves. The interaction with the notebook had the desired effect that all bar one participant elaborated on what was presented to them, spending, on average, 7 min per journey they discussed. However, some had difficulty recalling the rides despite the diary prompts, and experienced moments of difficulty orienting themselves on the maps. Andrews [16] reflected that when evaluating the visual user interface we can encounter issues of *buggy new interface, testing the wrong users* and the testers being *entrenched in the use of traditional interface*. In this study, while the users were right and the data notebook performed as intended, there was a clear tendency towards returning to the familiar interface. Four out of seven participants at some point wanted to consult the Strava record of their movement.

The Strava map in the Strava user's personal story (main user screen that contains all the journeys) does not offer features besides road layout, names (area and roads) and natural features (green areas and water bodies) Figure 5.11.1a. Strava users do have the option to see more detailed renderings with the possibility of selecting a landmark and a section of the journey. While the data notebook did not have that exact functionality, it does allow zooming in, and different maps display a range of landmarks (municipal and natural). The conclusion is that the difference is not in what the visual interface offers but that the repeated use trains visual and cognitive preceptors, creating shortcuts that help interpretation and understanding. The notebook they were presented within the study had more information, but that also meant a higher cognitive load, which made the task more challenging.



(a) Strava image from the personal story.



(b) Strava, more detailed image of the journey.

Figure 5.11.1: An example of the Strava interface. The interface does not offer more accuracy or information that is not present in the data notebook (except Elevation Gain and Max Elevation, which are not used for orientation.)

While four participants use Strava in their day-to-day, all of them document their cycling in some way. Rama uses social media, Kenda, Thea and Desa take photographs. All of which is a form of lived informatics [99]. This collection of evidence indicates the value cycling has in these women's lives.

5.11.1 Discussion on the Themes

We have seen that cycling plays an important role in this cohort's self-care practices and that six out of seven engage in cycling for well-being. The one participant who did not make explicit trips for well-being was a mother to a young family and research shows that young mothers experience barriers in engaging in self-care activities [22]. However, one of the main themes of this participant's interview was the increased independence and mobility that comes with cycling. Independence and increased mobility have a positive impact on one's well-being [268, 29] The other frequent common theme was fear of attack in parks and secluded areas. This aspect of female cycling is not mentioned in Western research, but a paper explor-

ing the propensity for female cycling in Solo, Indonesia [286] reports that the violence against women cyclists is one of the main barriers for the majority. There is also no number of attacks on cyclists in the UK (any gender). The absence of data, which must exist but is absorbed in other classes, in itself speaks of power imbalance and marginalization of cyclists. Marginalization of cycling has been discussed in terms of space allocation [65], which has an impact on safety on the roads [314, 265, 7], but not in terms of physical attacks. The third identified theme is the preference for round journeys (for example a different route coming home from the one going there). Further research needs to be conducted to further clarify the role of monotony vs the number of right-hand-turns in both directions. The number of right-hand-turns (which are challenging for cyclists as they have to cut through traffic) has not been explicitly mentioned but it is something that cyclists might be aware of on a subconscious level. All of these points could have an impact on inclusive city planning. We have established the importance of surroundings for cyclists in Study Two subsection 4.10.4 and that green areas play an important part in the cycling experience. Studies One and Two have also highlighted the seasonality of the cycling experience in terms of the time of day and year. However, there is also a day/night division. In all three studies, park visitations were the second most discussed journey type (after commuting) and cycling infrastructure often incorporates green spaces, which are less populated after dark and hence perceived as less safe.

Lam [178] rightfully argues for a more diverse infrastructure that would make journeys of care safer and accessible by the larger number of women at different stages of cycling proficiency (participants in Study Three had different attitudes to infrastructure depending on their cycling experience). And this should take into consideration paths that traverse unlit and less populated areas. The results of these three studies can strengthen the argument that all cyclists need a network of safe and accessible routes that will support their cycling irrespective of the season (Study One) or changes in their circumstances or life stage (Study Two), as well where they will feel safe (Study Three) — and which will enhance the benefits of cycling.

The finding that well-being and social bonding journeys are the most frequent is unexpected, as care journeys are associated with female mobility [254, 124, 178] and the most talked about journey, by both genders, in the first two studies was a commute.

The importance of cycling advocacy and its influence on transport policies and transport have been recognized [6, 67] but not much has been written regarding the importance and the direct impact it has on people's lives. The advocacy groups normalize cycling and provide a bridge between learning to cycle (or knowing the act but not how to apply it) and integrating that knowledge into the people's environment. They share the necessary knowledge and expertise (such as cycle routes, teaching basic checks, and advising on bike purchases and accessories).

Evaluating an interface with complex features, whose purpose is insight and narrative elicitation, is challenging and cannot be expressed in quantitative metrics. For example, the diary was consulted 31 times across the interviews, but only a handful of times did the subsequent conversation indicate that it was helpful. On the

other hand, the speed tracking provided pace and focus for the discussions. It was informative as it helped identify stop hills and in some cases areas of 'flow'. Combining movement with environmental representation proved an effective device for engaging participants and eliciting recollection. The success of the tracking interface seems to confirm Barbara Tversky's [307] assertion that we think spatially and that there is a strong link between motion, abstraction, and memory.

CHAPTER 6

DISCUSSION AND RESULTS

6.1 FINDINGS AND CONTRIBUTION

The objective of this body of work was to perform a series of empirical studies and analyze the results, in order to answer the following research question: to what extent do maps and visual representations of cycling physical and mental ecologies facilitate new insights and knowledge gain, regarding cycling experience and cyclists' interaction with their environment?

In order to do that, I have conducted a series of three studies, which I situated in the existing literature. The **contributions** in the field of information visualization and user experience design resulting from these studies are threefold:

1. **Methodological contribution** - I have presented three ways for combining maps, and mapped practices, with qualitative methods to elicit cycling experience.
2. **Advancing knowledge**- Exploration of the role that different forms of visualization or visual cues, play in eliciting the information.
3. **Furthering understanding** - I extracted particular insights into people's experience of cycling and the way cyclists relate to their environment.

Further, this work contributes to the field of visualization a in practical and methodological way. The three studies delved into the efficacy of visual stimuli for prompting engagement among cyclists. The first study developed a classification for the sketched augmentation of maps and the second study added an expanded corpus of of analytical methods for understanding the nuanced relationship between visual stimuli and cyclists' responses, thereby enhancing comprehension of the intricate dynamics between perception, experience, and spatial representation in active travel contexts. Methodological advancements in integrating data from various sources like GPS tracking, accelerometer readings, and user-generated content

enhance the richness and comprehensiveness of insights derived from visualizing cycling experiences. Visual representations of cycling routes and destinations shed light on how individuals perceived and interacted with their urban environments, while sociological inquiries into the meanings and symbolism associated with cycling spaces uncovered narratives of identity, belonging, and place-making among cyclists. There is a significant contribution to the field of active travel and cycling, especially to understanding priorities in cycling experience, behavior drivers, and identifying behavior formative factors. A special contribution was to the area of understanding female minority cyclists and their mobility.

I have found that combining visual cues with interviews is an effective method for enabling cyclists to explore, recollect, and express themselves. Participants in Studies One and Three favored using a combination of maps, as a variety of prompts helped to evoke different aspects of their journeys. While sketching, participants used combinations of techniques in an attempt to capture the multidimensionality of the cycling experience, but they struggled to use colour consistently. I propose that this might be related to how humans perceive and process quantities and that when categories increase to more than four [77], it becomes too challenging to retain the colour assignment, thus the colour role changes from indicating a certain class to indicating a change of topic (e.g. "This line is not same as that line."). The phenomenon of an intuitive comprehension of numbers below 5 and our ability to express complex concepts by sketching has been underexplored and is one of the avenues that my work opens.

Study Two has uncovered how people's relationship with cycling changes constantly and the importance of capturing that evolving relationship, as it might help us anticipate environments that will facilitate the change. Narrative analysis is suitable for small samples, The results of the analysis have demonstrated that we need to look at cycling holistically, and how it fits into people's lives as lives change, not just at a fixed point in time as evolution in people's lives has a profound impact on their mobility [202].

One of my assertions is that maps, tangible tokens, and visualization dashboards can help mitigate some issues that are present in surveys, such as primacy effect [309], where people refer to their most recent experience as it eclipses the previous ones.

We can see an example of this when we compare the results of the first study's initial survey with the topics extracted from the interviews. In the survey, one of the most important factors was weather Fig. .3.15a. However, we can see that in interviews, the weather was mentioned far less frequently Tab. section 3.9. As it could be speculated that this might be due to the lack of visual prompts regarding the weather, one was included in Study Two Figure 4.2.2. However, even with this inclusion, the weather was mentioned only by three contributors Tab. 4.10.1.

Capturing people's movements, and presenting them with means for visual analysis of the captured trajectories, is an effective way of gaining insight into people's cycling habits and attitudes. The advanced interactive combining of speed with tracking of routes was the most utilized component in Study Three.

My research question asked if these methods would enable knowledge gain, i.e. whether they would elicit new information. All three studies were analysed for themes, and have consistent and interesting results. One of the most prominent themes was the importance of surroundings to the cycling experience and cycling motivation. Regardless of gender, participants expressed that they prefer cycling longer routes if they are more pleasant; however, they will not do so if they feel they are time-constrained. Another theme that appeared in all three studies is the lack of connections and consistent cycling provisions. Also, a recurring theme is a pedestrian clash. This is a problem in London where a lot of quiet routes pass through areas of shared provision.

The hypothesis for the third study was that tracking women would expose the journeys of care and trip-chaining they have to do. However, only one participant did journeys of care and only two used trip-chaining. Instead of care, most of the journeys the participants did were for self-care, which is an unexpected finding. Also, the majority of participants expressed that they feel exposed when cycling and avoid quiet, open spaces.

6.1.1 Reflection on the use of the Probes

Cultural probes are designed materials whose purpose is to provoke a response and elicit data sharing from recipient [51]. They aim to engage and gamify data collection. Cultural probes are versatile tools employed across diverse fields for various purposes, often facilitating design processes [66] and easing data collection efforts, particularly in sensitive contexts. Whether engaging with children [256], addressing migrant experiences [259], or exploring intimate topics [166], cultural probes offer nuanced insights while minimizing intrusiveness and clinical detachment. The projects I deliver fall under the umbrella of probes as they aim to engage and provoke participants into shifting their response lense by inviting them to explore, examine and express. This section will shortly discuss the reactions of participants to the probes themselves.

To monitor the reception of materials in Studies One and Two each participant two questions :

1. **Did the materials used in this study help you express what matters to you in cycling?**

2. **Did the materials used limit your expression?**

In responding to the above questions, the majority of participants invariably talked about maps despite the presence of sketching materials and blank papers (one participant remarked on the usefulness of having a choice of colours). The questions were not asked in the third study for reasons that the conditions under which the sessions were run meant that participants couldn't fully explore and engage with the interface. The Study Three sessions were run in public places with ambient noise, patchy internet connection, and on a device that was not familiar to

the volunteers and with which they could not fully engage. Taking into consideration that they could not fully engage with the digital probe, their answers would not have come from the same level of experience as the answers in the first two studies and the concern was that the obstructions in running the sessions would colour the experience of the digital probe itself.

The majority of the participants in both studies stated that they found the materials helpful (only three said they were not). Some participants stated that they found the materials both helpful and restrictive at the same time. In the first study, the restrictivnes was due to the dominance of maps in the people's interaction. They commented that it imposed spatial thinking and, they thought more about "expressing where things happened, not what happened or how they felt". "I visualized my journey, rather than experience."
In the second study, the restriction was more geographical as the maps did not extend beyond the local borough. In support of their statements, participants who did find maps useful elaborated:

"If you had asked me straight away to draw, I would have struggled"
"I mean, different kinds of maps, make me think of different aspects of cycling"

However, some participants in Study One noted that the majority of the maps did not have cycling-related embeddings, even though they found the activity engaging.
"Aretifacts related to cycling would have helped. Like a helmet, for example"

Participants in the second study expressed that they have found the activity enjoyable and therapeutic. The allocated time for the session was two hours but some overrun and a couple of participants continued engaging with the material after the session was over and in their own time. The comments that people made were different from the comments in the first project. While the first project comments were positive, some participants in the second study expressed a great amount of enjoyment and even therapeutic experiences:
"I could have done this for much longer. I have a lot of anger."
"I really, really like doing this. It is really, really rewarding."
Both studies asked the participants the same question ("Express what matters to you when it comes to cycling.") and presented participants with maps, blank paper, and drawing material. The difference was that the embeddings in the first study were in the maps and were not explicitly task-related, hence the participants needed to mentally project their experience and then translate this into a creative output, which increases the mental load. In the second study, embeddings were transferred to the mobile tokens, which were cycling-relates, thus lowering the mental load and making space for **exploration, examination, and expression**.

TEAL

Design Considerations for Devising Visualisation Based Probes I have presented three studies using visualisation-based data-elicitation probes. Two probes were paper-

based ('analogue'). All three studies were well received by the participants and succeeded in capturing rich data corpus, as well as new insights.

The lessons learned during the process could be summarized as following design considerations:

1. **Accessibility and Inclusivity:** Ensure that probes are accessible to participants of diverse backgrounds, ages, and abilities, use simple language and clear instructions to facilitate comprehension, and provide alternative formats or accommodations for participants with specific needs.

2. **Engagement and Motivation:** Design engaging and motivating probes to encourage active participation, incorporating elements of creativity and personal expression to stimulate interest, and consider integrating gamification techniques or interactive features to enhance the enjoyment of the process (mobile tokens were better received than just maps).

3. **Functionality and Pilot Testing:** The task is the star and the main component of the probe. All the components accompanying the probe need to be tested, pre-tested, and refined so that the experience of entering the experience is positive and inviting.

4. **Simplify, Then Simplify again:** Consider your audience and how much time and energy you can ask of them. Taking that into consideration; develop the probe, test it, modify it, make it work smoothly, and then simplify it. When participants feel valued and that their time is being used efficiently, they are more focused and committed to the task at hand.

5. **Clarity and Transparency:** Clearly communicate the purpose and objectives of the study to participants, provide detailed instructions and examples to guide participants in completing the probes, and ensure transparency regarding data collection and privacy policies to build trust and confidence.

6. **Cultural Sensitivity and Relevance:** Consider cultural norms, values, and beliefs when designing probes to ensure relevance and sensitivity, avoid assumptions or stereotypes that may alienate or marginalize certain groups. Incorporate culturally diverse imagery, symbols, and references to resonate with participants from different backgrounds. If you are recruiting through an intermediary, ask questions, people are receptive to respectful inquiry.

7. **Set Clear Limitations:** Probes will always be incomplete, as will be data collected. As inclusive and relevant to individuals as we are trying to make them, they are, like all the data, just points in time and place. Every individual will stretch in a different direction from that point. These attempts at extension are valuable. They make a point in a vector, but the original overlap needs to be solid and well-defined.

6.1.2 Methodological Framework for Using Probes with Subgroups

The methodological framework I will describe here is the result of lessons learned during the studies I have conducted, incorporating insights gained from practical experience and ongoing scholarly inquiry. These steps are a collation of lessons learned during the implementation of the three studies. The value of data is that it tells us something about the people. So when working with probes, recruitment is the essential part, a foundation and bedding for the relevant data collection. While this is not necessary based on the theory of the probe methodology [51] I argue that divorcing the processes of designing from the social context is counter-productive. For the design to be situated, it is necessary to do more than understand best design practices [219] or even cultural conventions of the audience. Probe creation needs to be constructed as a *cultural production* [92]. The standpoint of a *cultural production* aligns with the main principles of data feminism [91] and situated knowledge [135]. Hence, for the effective design of the probe, it is essential to observe, engage and get the response from the relevant potential participants. The most effective way to do that is to **identify intermediary communities** which are the gateway to recruitment and the initial source of design parameters. The way potential participants function in their daily lives is a crucial aspect of probe development. An example of this is communication. Academic researchers tend to communicate with potential participants using channels which are regulated by their organization as these channels contain safeguards such as organizational procedures and protocols devised for best practices of data protection. Traditionally, that means using email. However, when designing the third study, it was explained to me that the groups I was trying to reach do not use email regularly. This meant that I had to modify my approach of communication and data collection where mini-surveys were sent by other means. In this case, that meant using a dedicated phone number for the duration of the study. Further, the group's relationship with the technology determined the design of the data notebook and the delivery of the sessions as I realized that expecting participants to own a device excludes a large number of relevant candidates.

Another important step in the development of participant work using probes is **testing and simplifying**. The importance of running a pilot study has been well documented and discussed in academic literature [311, 313] but it still gets overlooked when the project is on a tight time budget. In all three studies, pilot testing was a part of the process, which in some instances resulted in drastically changing the design (digital sketching was found to be unsuitable for the task and abandoned). Running a pilot, or several exposes weaknesses in our thinking and helps identify wrinkles. However, it does more than that, it helps identify redundancies, which brings us to the next step, **simplification** . Whatever your design is, it needs to be delivered to participants in the simplest, smoothest and unobtrusive way. The question you are asking and the design that carries it, need to be dominating the processes and not the other way around (as it is often the case).

Taking into account these considerations and based on the three projects described in this report, I proposed the following methodological framework.

1. **Learnings from Previous Studies** Incorporate insights from previous studies and practical experience into the framework. Adapt methodologies based on lessons learned during the implementation of previous research projects.

2. **Recruitment and Probe Design** Emphasize the importance of recruitment as the foundation for relevant data collection. Recognize the significance of situating probe design within the social context. View probe creation as a cultural production aligned with principles of data feminism and situated knowledge.

3. **Engagement with Intermediary Communities** Identify intermediary communities as gateways to recruitment and initial sources of design parameters. Understand the daily functioning of potential participants to inform probe development.

4. **Adaptive Communication and Data Collection** Adjust communication methods based on the preferences and habits of the target audience. Incorporate feedback from intermediary communities to tailor communication channels and data collection strategies. Utilize diverse communication channels such as dedicated phone numbers for effective engagement.

5. **Participant Work Development** Test and simplify probe designs through pilot studies to identify weaknesses and redundancies. Prioritize simplicity and smoothness in delivering probe designs to participants. Ensure that the research question and design remain central, minimizing complexity and obtrusiveness.

6. **Flexibility and Iteration** Remain flexible to adapt probe designs based on pilot study outcomes and participant feedback. Iterate on the design process to refine and optimize data collection methodologies.

7. **Documentation and Reflection** Document the development process, including recruitment strategies, design iterations, and outcomes of pilot testing. Reflect on the effectiveness of communication channels, data collection methods, and probe designs.

8. **Future Research Directions** Identify areas for further research and refinement of the framework. Explore opportunities for interdisciplinary collaboration and innovation. Consider the scalability and adaptability of the framework to different domains and data sources.

In conclusion, the methodological framework outlined here synthesizes lessons learned from practical experience and scholarly inquiry across three distinct studies. It underscores the importance of embedding probe design within the social context, advocating for a cultural production approach aligned with data feminism and situated knowledge principles. Emphasizing adaptive communication strategies, pilot testing, and simplification processes, the framework prioritizes delivering research questions with minimal complexity and obtrusiveness, ensuring a central focus on

participant needs and engagement. By acknowledging the dynamic interplay between methodology and context, this framework offers a structured pathway for effective data collection and interpretation within diverse subgroup populations.

6.2 Discussion

As mentioned in the introduction chapter 1, from the start of my PhD journey I wanted to adhere to Data Feminism principles as expressed by D'Ignazio and Klein [91]. The reason behind choosing this particular work is that it is the most cohesive and rounded example of guidelines for situated and mindful data engagement. One of the drivers behind my project was what I perceived as the lack of pluralism, consideration of context, lack of understanding of binaries, and consideration for the importance of emotion when it comes to cycling. The findings from the studies described in the thesis show that this strips away a crucial element when considering the promotion of cycling and improving cycling conditions. In writing the final discussion, I wish to reflect on and incorporate the said principles.

1. **Examine Power** - the ways in which cycling data is collected and the contributions formed have been examined in the chapter 1, and chapter 2. We have established that cycling is male-dominated and women are poorly recognised and represented when it comes to cycling narratives. Article [125] which discusses the realities of gender, and examines the existing literature on gender in cycling, concludes that the research relies on gender binaries, without reflection on gender differences that underlie the different cycling patterns. This is even more evident for minority women. 2005 government report states that only 7% of cyclists are of BAME background and that the BAME women are the least represented group. A more recent report by the cycling charity Sustrans [293] finds that 74% of ethnic minorities in 12 cities do not cycle.

   However, maps and visualisations also have power. They represent a particular worldview [68, 276]. Maps are effective in stimulating a response, but as it is a simulation of reality, the attributes they contain bias the output and can be leading.

2. **Challenge Power** -Individuals that are already engaged in advocacy tend to be the ones who are more open to volunteering but are not necessarily representative of the wider population. This is in line with Pareto's Principle, where 20% of the population provides the information on 100% of the population [273]. Through this work, an effort has been made to diversify the participation and enable access to a variety of cyclists, including, so far poorly represented, women of ethnic minority.

   Further, the studies have given participants an opportunity to create their own versions of maps, which reflect their own experience of the world. In that respect, Studies One and Two are examples of counter-mapping [298]. The augmentations, sketches, and tokenized base maps are each an individual take, a

comment on the existing structure, its validity, effectiveness, and interpretation.

3. **Embrace Pluralism** - 'Big Dick Data' vs Little Feminist Data. Big Dick Data is an academic phrase coined by Lauren Klein and Catherine D'Ignazio to describe fetishising of the big (masculine) data with its exaggerated sense of certainty, as Harrawya succinctly put it; "A God trick". It goes hand in hand with the phrase 'Data is the New Oil', which big corporations have the means to mine. What data do they collect and what questions does this data try to address? The findings often become self-perpetuating, as they are taken to be the truth. It becomes common rhetoric, and people tend to repeat as their own what they have heard, due to the social desirability bias [172]. Large data is difficult to obtain for studies that require active participation. To illustrate this, I will present recruitment for a quantitative survey-based study. A study of attitude to cycling conducted in the US [98] sent 10,000 invitations, followed by reminders and follow-ups. It managed to secure less than 10% participation. The initial selection was random, but the final sample seems to be skewed towards educated (mean 4.4 on a scale 1-6), white (77%) individuals with good household income (mean of $70,000 which is more than average according to [170]). While a small sample cannot be generalised, no sample can be said to be truly representative of the whole strata of any part of society. Even with the best intentions, surveys and 'Big Data' tend to overlook minorities and bypass intersectionality. These are also the findings of research looking into ethnic minority response rates in health surveys [158] and the study examining the relationship between non-response to surveys and the demographic characteristics of the sampling [282]. The skewed results might be due to the effects of homophily in sampling (people unconsciously recruiting participants like them by use of language). Homophily is recognised in recruiting [69] and social mobilisation [13]. The data in the studies discussed in this thesis is 'little' data that is situated in understanding and actively seeks diversity.

4. **Rethink Binaries and Hierarchies** - We are all flaneurs. The third study addresses the mobility of a poorly recognised group. However, besides elevating and exposing the female experience, my work also elevated and exposed neglected and overlooked aspects of the male experience. As mentioned in the introduction, the cities favour radial structure to the road and cycling network, which has roots in the economy and economic needs. Lam [178] equates that structure with a masculine and goal-oriented work commute. However, one can say that this argument furthers gender division by associating the needs of the worker as male and the needs of the carer as female. As the topic of this work is not an assignment of gender roles, my aim is not to challenge but simply to present the evidence which might expand our considerations when thinking about and planning spaces for cycling. The bicycle is a different mode of transport from others that we use to move around the city. It is faster than walking, but it lets its users experience the surrounding environment in a similar way to pedestrians, as there is no filtering barrier as in motorized vehicles. From the first study, there was evidence of the connection

to, and the importance of, the environment. Participant One in Study One created a sketch map that contained the safe and unsafe infrastructure, as expected, but also routes that were classified and labeled as "not fun", as well as some alternative routes. They described four routes between their place of work and their home. Also, Participant Five created an ideal bicycle route that contained not only a network of side roads but also a main and an alternative route. A survey-based study [98] examines attitudes to cycling in small US cities, and finds that the factors influencing them are safety and household responsibilities, whilst social and environmental factors have no impact. This is in direct opposition to my findings in all three studies, where participants of all genders rate surroundings highly on their list of important factors.

My findings are that cycling enables Flannery [302] and has strong elements of psychogeography [64] for both genders. Participants in all studies remarked that they tended to single out spaces that enabled exploration. Infrastructure, while providing safety, was remarked on as restricting and in some instances as tiring despite being safer.

5. **Elevate Emotion and Embodiment** - Participants in all three studies expressed that the experience of the immediate surroundings is one of the most important elements when cycling. Joy and independence were found to be expressed by participants of both genders, as was the role of cycling in self-care. Freedom to augment the maps in Study One introduced these concepts into the vocabulary, and they were fully adopted in Study Two through the use of tokens. Study Three gave participants an opportunity to comment and describe how the spaces they move through affect them; from peace and reflection to fear for one's safety.

6. **Consider Context** - Study Three finding that well-being and social bonding journeys are the most frequent is unexpected, as care journeys are associated with female mobility [254, 124, 178]. Also, the most represented journey by both genders in the first two studies was a commute. It might be argued that the care responsibilities are a barrier to cycling [254] and that this is behind the low percentage of female cyclists in general[231]; but this assumes that most women are mothers, or mothers to young children, or have such dependants. As we can see from the studies, parenthood has its stages, and it is not the primary factor determining female mobility, even for individuals who have children.

   Also, I have striven to be transparent regarding social, cultural, institutional, and material conditions in regard to all parts of the study. However, I have not explained my position and I am taking the opportunity to do this now. I am a female cyclist of a certain age and gravitas. I have cycled all my life, and have brought up my family to cycle. I fell in love with data visualization as a means to communicate complex ideas and gain insights. After delving into available datasets, I noticed a lack of representation and selectivity that favored numbers but omitted experience. By embarking on this research path, I wished my work to be a platform for an under-represented minority of cyclists, and

to create a way to capture, and extract, aspects of cycling that have previously been deemed difficult, personal, or irrelevant.

7. **Make labour Visible** - All three studies use Open Source Map (OSM)s. The open source software is the result of volunteer labour, as individuals not only gift their time, they donate their knowledge [321]. The effort behind OSMs is rarely recognised or acknowledged. Also, the findings of the third study highlight the importance of advocacy groups in shaping and promoting cycling. While Aldred [6] finds that cycling is shaped by social movements and reflects on the larger implications it has on policy forming, this work reveals a more direct, grass-roots impact it has on promoting cycling and empowering individuals.

6.3 Recommendations for Future Work

The three studies described here were both proofs-of-concept as well as springboards for further exploration. The work with the maps in the first study has raised questions regarding the relationship of participants with visual embeddings in maps. This was further explored in Studies Two and Three but warrants much closer scrutiny. We have seen from Study Three that labels without other factors are not as effective, and in Study Two that specialised vocabulary icons are good vehicles for expression. However, the open question is still what role do colour, and feature placement play? In Study Three we have seen that clutter is alienating, but that context overrules this. The exploration of maps with the same context but different levels of clutter could reveal the effects it has on engagement.

The first study's thematic analysis was the basis for the tokenized vocabulary of the second study, but it has also created another vocabulary that has gone unexplored, i.e. the visual abstraction vocabulary of passage through geographies that acknowledges its environment. Could further study of how people endeavour to represent these abstractions help us understand better how they could be communicated more effectively?

Also, the studies have demonstrated the importance of surroundings for both genders. Further work that would explore and capture the equality of the need for a safe, well-connected and pleasant cycling network would help equalise the rhetoric, which at the moment is that only women need/want it. Further, more research into female cycling and minority female cycling that examines the actual mobilities of women and puts this into contexts such as cycling proficiency and competency, might benefit our understanding in order to produce actionable measures that will help create social, and urban environments for women who do and wish to cycle.

The methods and framings presented in this thesis deal with phenomena that are happening across geographical and temporal scales. They can be adopted and applied to other transport studies as well as broadly outside this field. Mobility over space and time occurs in a variety of settings and situations. Some examples of the possible applications and modifications include the exploration of the environment

on perceived social mobility and the effectiveness of healthcare provision in certain geographical spaces. Further modifications can be made to the types of maps used, as not only geographical places can be mapped, but there are also different journeys people take whose validity, effectiveness, and impact can be explored in this way (e.g., different points in an illness treatment or educational path). The processes of general exploration, vocabulary development, and contextualization using individual data-based stimuli can be used in instances where flows over time and space are present and interact with a structure that can be mapped and visualized.

EXISTING WORK ON FOUND THEMES

Break-in-flow was one of the most common themes in all three studies. A recent study of hire bike journeys looks at the connectivity between London boroughs from the commuting perspective as it calculates connectivity based on origin-destination data[27].

A work by Ockwase [235] is looking at male cyclists and the barriers to cycling they experience.

Ravensbergen et al. [253] also examine existing research literature, research gendered cycling, and challenge the purely binary conceptualisation of gender cycling, while recognising the difference in patterns of mobility that are due to different gender roles. They state that research into cycling should incorporate a deeper understanding of gender roles in order to contextualise the differences that quantitative methods have uncovered.

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Appendices

.1 First Study

.1.1 The First Study Pilot Documentation

Due to formatting idiosyncrasies, this page is blank and the content continues from the next page.

Study title: Qualitative Visualisation: Friction and Flow in Everyday Life of Cyclist
Researcher: Mirela Reljan-Delaney, [redacted]
Supervisor: Dr Jo Wood, [redacted]

Dear participant,

I would like to invite you to take part in the pilot study that is a part of my PhD studies. The results from the pilot will be used to inform methodology and the approach for the main project. All the data that results from our interaction will be anonymised as much as possible in that your name and the exact address will not be recorded. However, you will be asked to complete a questionnaire regarding some demographic characteristics. You can answer just the questions you are comfortable with and you can withdraw from answering any. With your permission, the session will be audio recorded and transcribed. Transcription, questioner and any materials that result from our interaction, will be kept on secure university servers and the outputs you provide, and any collected information, will not be used in any publication and will not be seen by anyone except me and my supervisors.

Before you decide whether you would like to take part it is important that you understand why the research is being done and what it would involve for you. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information.

What is the purpose of the project?
The project is looking intersection of qualitative techniques and psychical stimuli for the purpose of capturing and expressing cycling experience. The project is a part of my PhD studies, where different theoretical approaches will be applied to analyse the observations.

Why have I been invited?
The purpose of a pilot is to test the feasibility of the main project on a sample of participants that can be excluded from the main project. It is a very important part of the process as it allows the researcher to optimise the study, examine the feasibility of the process and the validity of their assumptions. You have been invited because you partake in the relevant activity and live in the chosen geographical area.

What you will be asked to do?
During our session, you will be asked to reflect on your cycling journeys and use materials provided to express your experience. The study will be divided in five sections.

1. Pre-task for which you will need to provide me with approximate origins and destinations of cycle journeys, read project information and consent materials and fill in a demographic questionnaire.
2. Session introduction and familiarisation with materials by the session leader
3. Individual activity of participant self-reflection and expression by use of the materials provided. This is a paper-based study and materials used will in the form of stationary supplies.
4. Elaboration of the participant's outputs in a recorded conversation.
5. Post-session follow-up on any subsequent thoughts and reflection by means of pre-stamped postcard.

Do I have to take part?
Participation is voluntary, it is up to you to decide whether to take part. You can choose not to participate in part or all the study. You can withdraw at any stage of the study without being penalised or disadvantaged in any way. If you do decide to take part, you will be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason.

What will happen if I take part?
I will send you the pre-task, that is outlined above. If you wish to proceed, we will agree mutually convenient time for a one-off meeting at your home. During the meeting you will be asked to perform tasks outlined in the section' What will I need to do?', points 3 - 5.

What are the possible disadvantages and risks of taking part?
There are no foreseeable risks or harms or possible side effects for participating in this study. Your personal data, comments, and any other information you provide will be kept confidential and secure. I will be looking for patterns that persist across the observations and not at individual behaviours. The research is about understanding the decision drivers and capabilities of expression space, not about judging what you do in any way.

What are the possible benefits of taking part?
While there are no specific benefits of taking part, I hope you enjoy the experience of participating in the research. However, as a result of the exercise, you might take a more reflective view of your cycling habits and this might lead to more immersive experience.

Will my taking part in the study be kept confidential?
The data will be kept by the researcher for possible re-use in development of the subsequent projects for the duration of their PhD and will be retained until it is no longer of any development value. Your real name will not be included at any time and you will be de-identified in audio recordings or transcripts made of.

What should I do if I want to take part?
Read, fill out and sign the participant informed consent form.

What will happen if I do not want to carry on with the study?
You are free to withdraw from the study at any time without giving a reason and without being penalised or disadvantaged.

Data privacy statement
City, University of London is the sponsor and the data controller of this study based in the United Kingdom. This means that we are responsible for looking after your information and using it properly. The legal basis under which your data will be processed is City's public task.

Your rights to access, change or move your information are limited, as we need to manage your information in a specific way in order for the research to be reliable and accurate. To safeguard your rights, we will use the minimum personal-identifiable information possible (for further information please see https://ico.org.uk/for-organisations/guide-to-data-protection/guide-to-the-general-data-protection-regulation-gdpr/lawful-basis-for-processing/public-task/).

City will use your name and contact details to contact you about the research study as necessary. The only people at City who will have access to your identifiable information will be Mirel Reljan-Delaney. City will keep identifiable information about you from this pilot for weeks years after the pilot has finished.

You can find out more about how City handles data by visiting www.city.ac.uk/city-information/legal. If you are concerned about how we have processed your personal data, you can contact the Information Commissioner's Office (IOC) https://ico.org.uk/.

What will happen to result of the pilot?
The results of the study will inform the creation, structure and methods that I will use in the subsequent phases of the primary project, which will the focus of my PhD thesis. The information from the pilot will not be published, used in teaching, or any other research.

Who has reviewed the pilot study?
This study has been approved by my supervisor Professor Jo Wood and the director of giCenter Professor Jason Dykes.

What if there is a problem?
If you have any problems, concerns or questions about this study, you should ask to speak to a member of the research team. If you remain unhappy and wish to complain formally, you can do this through City's complaints procedure.

.

Further information and contact details
Researcher: Mirela Reljan-Delaney, [redacted]
Supervisor: Dr Jo Wood, [redacted]

Thank you for taking the time to read this information sheet.

Study title: Qualitative Visualisation: Friction and Flow in Everyday Life of Cyclists

REC reference: ETH1920-0753: Mirela Reljan-Delaney (Low risk)

Researcher: Mirela Reljan-Delaney, [redacted]

Supervisor: Dr Jo Wood, [redacted]

Thank you for taking the survey and helping us with our study. Most of the questions ask for a concise answer, but if that limits your ability to truly express your experience, feel free to elaborate.

Before we start, please confirm that you have read the participant information sheet regarding the purpose of this study and the data collection, been informed of how the results will be stored and that you have been made aware of your rights and you are happy to take part.

1) What is your age? _____

2) What gender do you identify as?

Male Female Non-Binary Other Prefer not to say

3) What is your profession? _____

4) What is your main mode of transport? _____

5) How long have you been cycling? _____

6)How long have you been cycling in UK? _____

7) Do you cycle with children? (Either using a child seat or accompanied.)

Yes

No

8) How often do you cycle?

- Daily
- Occasionally
- Regularly

9a) If **daily**, on average, how many destinations you visit in a day?

- Monday ___
- Tuesday ___
- Wednesday ___
- Thursday ___
- Friday ___
- Saturday ___
- Sunday ___

10a) In one word, how would you describe the purpose of the trips e.g. commuting, pleasure, shopping? If there are several destinations, list them all.

- Monday _____
- Tuesday_____
- Wednesday_____
- Thursday_____
- Friday_____
- Saturday_____
- Sunday_____

11a) In one word, how would you describe the trips, disregarding their purpose? If there are several destinations, describe each.

- Monday _____
- Tuesday_____
- Wednesday_____
- Thursday_____
- Friday_____
- Saturday_____
- Sunday_____

12a) What is your favorite day for cycling? You can choose multiple days.

Mon

Tue

Wed

Thur

Fri

Sat

Sun

13a) What makes your cycling experience on this day stand out?

_____

_____

14a) In a few words, what makes cycling difficult?_____
_____

_____

9b) If **occasionally/regularly,** how often do you cycle? _____

10b) When you cycle, on average, how many destinations you visit in a day? _____

11b) In one word, how would you describe purpose of your cycling trips? (Give as many answers as you see appropriate) _____

12b) In one word, how would you describe your trips, disregarding their purpose? (Give as many answers as you see appropriate) _____

13b) What is your favorite routine cycle? _____

14b) What makes your cycling experience stand out?

_____

_____

15b) In a few words, what makes cycling difficult?_____
_____

_____

16) On your usual trips? How much do you deviate in your routine and why?

_____

_____

17) Do you use any visual navigation tools in relation to your cycling?

Yes

No

18) If yes, how effective you find them in relating information that is relevant to you?

_____

_____

19) What is important to you about cycling?

_____

20) How do you find the preferred routs? Which tools, resources and techniques do you use?

_____

_____

Thank you very much for taking part in our study and for completing the survey.

Overview of the 1st pilot for the 'Qualitative Visualization: Friction and Flow in Everyday Life of Cyclists'

Number of participants: 4

Location: participant's home

Session duration: 2 hours

Techniques used: questionnaire, map augmentation, sketching and interview.

Pre-task: Sending me the origin and destination postcodes of their journeys and reading the project information sheet. In the main study the OD location will be a part of the recruitment process. The reading of the information will be a pre-task.

First task: The participants were asked to visually express their cycling experience and were presented with a range of art materials to use blank paper, various map representations, markers, pens, colored paper, playdoh and post-it notes). First three participants were asked to visually express themselves and annotate their work, but this has resulted in people relaying on text to express themselves.

Second task: Draw your cycling. The participants were asked to express their cycling visually, without annotation. They were not asked to draw a map, however all of them did.

Session structure:

- Introduction, welcome and thanks.
- Conversation regarding clarity of information in the pre-task sheet, answering participant's questions and signing of the consent form.
- Introduction of the first task to the participant.
- First task.
- Recorded interview with the participant, where they explain what they did and why. At of questions used can be found in Interview Questions section.
- Second task.
- Annotate your drawing.
- Recorded interview regarding the drawing and suitability of media for the purpose.
- Recorded interview regarding cycling and the use of visualization. Purpose, usefulness, suitability.
- Post-task: pre-addressed and stamped postcard, with any feedback or incubated thoughts, to be mailed to me.
- Thank the participant for their cooperation.

Observations and changes:

- People have multiple destinations within one journey.
- Participant prefer destination points on the maps. This was left out as I wanted them not to think linearly. The thinking was, that if there are no OD points, the participants will consider the space in terms of neighborhood and express themselves more broadly. However, this has proven to be difficult.
- Should not use word annotate till after the drawing tasks as people default to writing.
- If representing OD needs several A3 maps, need to connect them beforehand.
- People tend to reminisce about past regular destinations and sections of past commutes.
- Some questions in the questionnaire needed to be modified. (See attachment for the updates.)
- Most of the participants use words of mouth and trial-and-error for route optimization. Sparse use of maps or any other official information sources.
- People like hills.
- People know what they want to express, but don't know how to express them visually?
- Cycling matters to people who cycle. A lot.
- Need to improve the post-task. Alex Tylor is right, that it needs to be more like cultural probe.

Interview questions:

Most of the interview questions were discussing what people did and why. However, there are some questions that were same for all:

- Can you recognize things you have described without annotation?
- Is there anything you need to change? Add?
- Were the materials provided sufficient?
- Do you feel that have managed to capture your cycling experience?
- If not, what would have helped you do so?
- If you had a map that incorporates some of the things you have identified, you would use it?
- Do you think that other cyclists would use it?

Attachment 1
An updated Questionnaire

Study title: Qualitative Visualisation: Friction and Flow in Everyday Life of Cyclist

Researcher: Mirela Reljan-Delaney, [redacted]

Supervisor: Dr Jo Wood, [redacted]

Thank you for taking the survey and helping us with our study. Most of the questions ask for a concise answer, but if that limits your ability to truly express your experience, feel free to elaborate.

Before we start, please confirm that you have read the participant information sheet regarding the purpose of this study and the data collection, been informed of how the results will be stored and that you have been made aware of your rights and you are happy to take part.

1) What is your age? _____

2) What gender do you identify as?

Male Female Non-Binary Other Prefer not to say

3) What is your profession? _____

4) What is your main mode of transport? _____

5) How long have you been cycling? _____

6) How long have you been cycling in UK? _____

7) Do you cycle with children? (Either using a child seat or accompanied.)

Yes

No

8) How often do you cycle?

- Daily
- Occasionally
- Regularly

9a) If **daily**, on average, how many destinations you visit in a day?

- Monday ___
- Tuesday ___
- Wednesday ___
- Thursday ___
- Friday ___
- Saturday ___
- Sunday ___

10a) In one word, how would you describe the purpose of the trips e.g. commuting, pleasure, shopping? If there are several destinations, list them all.

- Monday _____
- Tuesday_____
- Wednesday_____
- Thursday_____
- Friday_____
- Saturday_____
- Sunday_____

11a) In one word, how would you describe the trips, disregarding their purpose? If there are several destinations, describe each.

- Monday _____

- Tuesday_____
- Wednesday_____
- Thursday_____
- Friday_____
- Saturday_____
- Sunday_____

12a) What is your favorite day for cycling? You can choose multiple days.

Mon

Tue

Wed

Thur

Fri

Sat

Sun

13a) What makes your cycling experience on this day stand out?

_____

_____

14a) In a few words, what makes cycling difficult?_____
_____

_____

9b) If **occasionally/regularly,** how often do you cycle? _____

10b) When you cycle, on average, how many destinations you visit in a day? _____

11b) In one word, how would you describe purpose of your cycling trips? (Give as many answers as you see appropriate) _____

12b) In one word, how would you describe your trips, disregarding their purpose? (Give as many answers as you see appropriate) _____

13b) What is your favorite routine cycle? _____

14b) What makes your cycling experience stand out?

.1.2 Research Protocol for the First Study

Qualitative Visualisation: Friction and Flow in the Everyday Life of Cyclists

Research Protocol for Ethics Application, v1.1

Mirela Reljan-Delaney (Researcher), Prof Jo Wood (Supervisor), Dr Alex Taylor (Second Supervisor), Prof Sheelagh Carpendale (External Advisor), Prof Jason Dykes (Internal Advisor)

Introduction and justification

Cycling; barriers to cycling; effectiveness and optimisation of infrastructure; and social perceptions of cycling have been the subject of a wealth of theoretical inquiries [1]–[7]. The number of cycling-related academic publications has increased thirteen-fold in the period between 1995 and 2016 [8].

Cycling itself is becoming more popular and many urban areas, like London, are reporting an increase in cycling journeys [9]. Across the literature, there is a consensus regarding the main factors affecting the probability of cycling uptake; good infrastructure and safety [6], [10]–[15]. These findings are recognised by planning authorities [9], [13]. Yet, according to TfL's report [16] , despite publicised investments in infrastructure, there is no significant increase in the number of cyclists – and the gender and cultural demographics for cycling is predominantly of the white, middle-class male population. The discrepancy between the amount of knowledge generated, implementation, and the effect it generates, leads me to re-examine and try to re-define some of the tenants inherent in the process.

In her work Lam [17] takes the example of London borough of Hackney and challenges decision-making process and effectiveness of new cycling infrastructure, asserting that cycling advocacy does not reflect the borough's diversity and hence, does not answer the needs of the most its population. Furthermore, Lam posits that in order to diversify the cycling narrative, we need to contextualise quantitative information by complementing their findings using qualitative methods. This thinking is echoed by Krizek [18] who strongly argues that in order to ascertain the intrinsic value of cycling, we need to look beyond functional characteristics and identify the hidden landscape of unique aspects of cycling experience.

The impact – and importance -- of invisible data has been made evident through the work of Dr Aldred who, by means of one-day diary method, collected instances of unreported near-miss incidents [19], [20] across the UK. The warm reception her work received from cyclists and cycling stakeholders revealed that there is a ready audience for new ways of collecting data.

Dr Aldred quantified her data, however, she recognised the importance of insights that her participants achieved, which were a side-effect of reflecting on their journey [21]. Working with a diary format, and employing a mixed-method approach, Gamble et al. [22] seek to challenge the traditional approach to data collection and the role of cyclist's experience in city planning. Gamble adopts principles of situated knowledge [23] and merges them with

statistical methods in order to reveal human perceptions of what is traditionally expressed as functional outcomes – cycle journeys.

In their approach Gamble et al. introduce images as a prop that supports and elaborates cyclists' narrative. However, I argue that visualisation and visual prompts can have a greater role in supporting the discovery of the cycling experience.

While Gamble et al.'s work revealed some interesting results, the method of data collection required competent and dedicated participants, in this case, a group of cycling activist. This limit in the sampling further propounds the issues that Lam has raised in their work [17] in that does it is not inclusive of the less represented socio-economic, gender and racial groups

By further exploring the tenets of situated knowledge in this context, the research is inevitably lead to the intersectionality of feminist theories and data [25]–[27], which not only embraces the idea that knowledge is context-dependent, but in fact advocates *for* inclusivity and social awareness.

In her work on visual analysis and design, Munzner [24] reflects that data visualisation is most effective when we need 'human in the loop'. This assertion works two ways; human needs visualisation to make sense of phenomena that are hard to grasp, and the role of visualisation is to improve human understanding and perception. The Gamble et al. method relies on a driven and proficient participant. I argue that surrogating the actual journeys with visual, geospatial representations would facilitate insight and reflection in an accessible way. My research aims to uncover which type of visual presentations are the most effective in eliciting responses, as well as documenting the insights revealed.

The outcomes of this study will form a significant part of my PhD thesis.

Design

Method

To generate the data I will conduct a series of one-to-one workshop/interviews that will be supported with two types of questionnaire. The first questionnaire will collect personal and cycling demographic information, while the second questionnaire will aim to collect feedback on the process and participant's reflections, which might surface after the process of contemplation has been initiated during the workshop.

The general, philosophical framework rests on the principles of situated knowledge [23] and relativism [29], where reality is dependent on individual perception. The analytical method falls within the family of mixed-methods [30], which combine both qualitative and quantitative data and analytical approaches. There are several mixed-method designs that depend on the purpose of the study and the order in which the data will be analysed. Taking into account transformative nature and the aim of the study and social justice, the design

aligns with all the aspects of this project; a mixture of qualitative and quantitative data; feminist perspective; addressing social inequality and a complementary mixture of quantitative and qualitative analysis.

Participants

The sample size for this study needs to satisfy both criteria for qualitative and quantitative analysis. For medium-size qualitative study conducting thematic analysis, the expectation is 15-20 participants [31]; statistical nature of quantitative approach demands a greater number. Hence, my aim is to recruit a minimum of 30 and maximum of 50 participants. It is important to bear in mind the possibility that qualitative analysis will reach the point of saturation, when no new insights are being discovered before all the data is analysed.

The sample will be chosen from the volunteers recruited at my place of study; City, University of London. This decision is mostly based on operational considerations. Recruiting within the university gives me access to a large number of potential participants; makes communication easier; the validity of the study is not in question as volunteers are familiar with the organisation; finding space for running the workshop is less of an issue and the commute to and from the workshop is minimal for the researcher and the participants. On the minus side, recruiting within the organisation will limit the diversity of the sample in the aspect of economic class and education level. To mitigate this, the recruitment will not be limited to the student and academic bodies but include administrative and custodial staff.

The be included in the project, volunteer needs to identify themselves (self-nomination) as a person that cycles, and to have done so in London within the last year. The study is aimed at the adult population and all the volunteers need to be 18 years of age, or over. There is no upper age exclusion marker. There is no gender-based exclusion criterion, but I aim to have a diverse and inclusive sample. However, the sample make-up might be dictated by the local demographic and thus, beyond my control.

Volunteers that fall within a group of vulnerable adults for reasons of psychological or mental deficiency will be excluded for reasons that I lack the training needed to provide a safe and supportive environment to individuals with extra needs.

Procedure

Stage	Detail	Involved Parties
Compilation of the research protocol	Identify components needed to satisfy the research question and structure the research design.	Researcher Supervisor Internal advisor
Pilot for the study	Recruit a small participant sample in order to test the validity of the assumptions made in the creation of the protocol. No data collected at this stage.	Researcher Pilot participants
Modify the protocol	Act on the pilotfindings, modify the protocol.	Researcher Supervisor

		Internal advisor
Ethics approval	Apply for approval from the Computer Science Ethics Committee at City, University of London.	Researcher Supervisor City CS Ethics Committee
Participant recruitment	Recruit participants by means of internal advertising. Acquire individual consent and set the dates for the individual session.	Researcher
Data collection	The researcher will use mixed-method and the data collection will reinforce this. Quantitative data will be collected by means of the initial questionnaire and post-study feedback. The questionnaire will consist of closed and open questions as its purpose is two-fold. Firstly, it will provide a quantitative element which will be used to support and enrich the qualitative analysis. Secondly, it will prepare the participants for the workshop and start the process of reflection. The workshop sessions will be on the one-to-one basis in order to ensure that participants do not feel self-conscious regarding their sketching skills and do not filter their speech during the interview. The workshop will consist of two parts. The participants will be given a range of art materials and map representations. They will be invited to sketch out their cycling experience using the materials provided. Once that task is done, the participants will be asked to annotate and verbally explain what they did. The interview will be audio recorded, provided participants agree. Data collected from this stage of the study will be: • Sketches and visual augmentation of the maps in the form of drawings. • Text The participants will augment the sketches with explanations. • Audio recordings capturing the interview. The electronic feedback form will be emailed a week after the workshop via email and will be hosted on the university-approved platform Qualtrics. While the original intention was for participants to send feedback and incubated thoughts via pre-stamped and addressed postcard, the pilot has shown that this	Researcher Participants

	ineffective as none of the five pilot participants have mailed their follow-up response. The participants will be able to opt-out at any point in the proceedings.	
Proposed analysis	The collected data will be analysed using the idiographic approach of thematic analysis and combined with statistical analysis of demographic and geo-spatial characterises collected by the questionnaire and present in the visual artefacts used by participants. Unlike purely qualitative, quantitative and the majority of mixed methods, the social justice research design method has no defined template that the researcher has to follow. It is both experimental and exploratory and provides a certain degree of flexibility. [30]	

Practical Issues

There are several practical concerns regarding this study. Firstly, inferring from work read during the preparation for this study, it is difficult to recruit a desired number of volunteers. The pilot study has shown that cyclists, on the whole, are willing participants. However, this might be a result of the fact that the cyclists used in the pilot were familiar with the researcher. The staff and students at the university are frequently lobbied for participation and hence, less likely to volunteer. If the recruitment proves to be an issue, an alternative source of participants will be considered.

Another practical issue is the transcription of the audio recordings. The transcription service needs to comply with GDPR regulations and be approved by the university. The cost of transcribing one two-person 60-minute recording is £90. Transcribing all the interviews would exceed the research budget for this study. In order to circumvent this obstacle, a small number of representative interviews will be transcribed.

The largest practical issue regarding this study is the scope. A combination of quantitative and qualitative approaches is usually a team undertaking. In order to manage it, I will divide the study into phases, which will build on each other.

Ethical Concerns

The main ethical issue concerning this research is preserving the anonymity of the participants. This is especially challenging as the pilot has shown that during the sketching part of the study participant will mark places of interest on the geospatial representations at their disposal. In order to mask their identity, any sketches that are to be used in any sort of

publication will avoid such overt marking or the residence mark will be changed/omitted/occluded (as is best appropriate) in order to protect participant's privacy.

Other measures to ensure transparency, anonymity and privacy are:

- Participants will receive full information regarding the study. They will be informed of the purpose of the study, data handling, possible of exposure of the material due to publication and other uses and any negative effects that might be brought on by the study.
- Participants will be informed of their right to withhold their further involvement and participation in the study at any time prior to the publication of findings.
- Informed consent will be obtained before the start of the study.
- All the data (outcomes of the workshops, questionnaires, audio recordings) will be anonymised and only the researcher will be able to connect participants with their data. This will be possible in order for the researcher to destroy participant's outputs in case they wish to withdraw from the study.
- If a participant would opt-out, the notes and raw materials will be shredded and disposed of through universities' confidential disposal service. All electronic files would be deleted.
- The participants will be re-assured that the aim of the study is to detect patterns and generalise emerging themes, not pass opinions or judgments on individual habits and behaviours.
- De identified data will be securely kept at the university's server and all the raw materials in the lockable cabinet at the university. Only the researcher will have access to the data prior to the anonymisation process.

Timescale

The start date of the study depends on the date of the ethics approval. Assuming the approval was granted the recruitment will commence straight away. As the sessions are on a one-to-one basis, the workshops times will depend on the availability of participants. My aim is to conclude data collection and start the analysis by the 15th February 2020.

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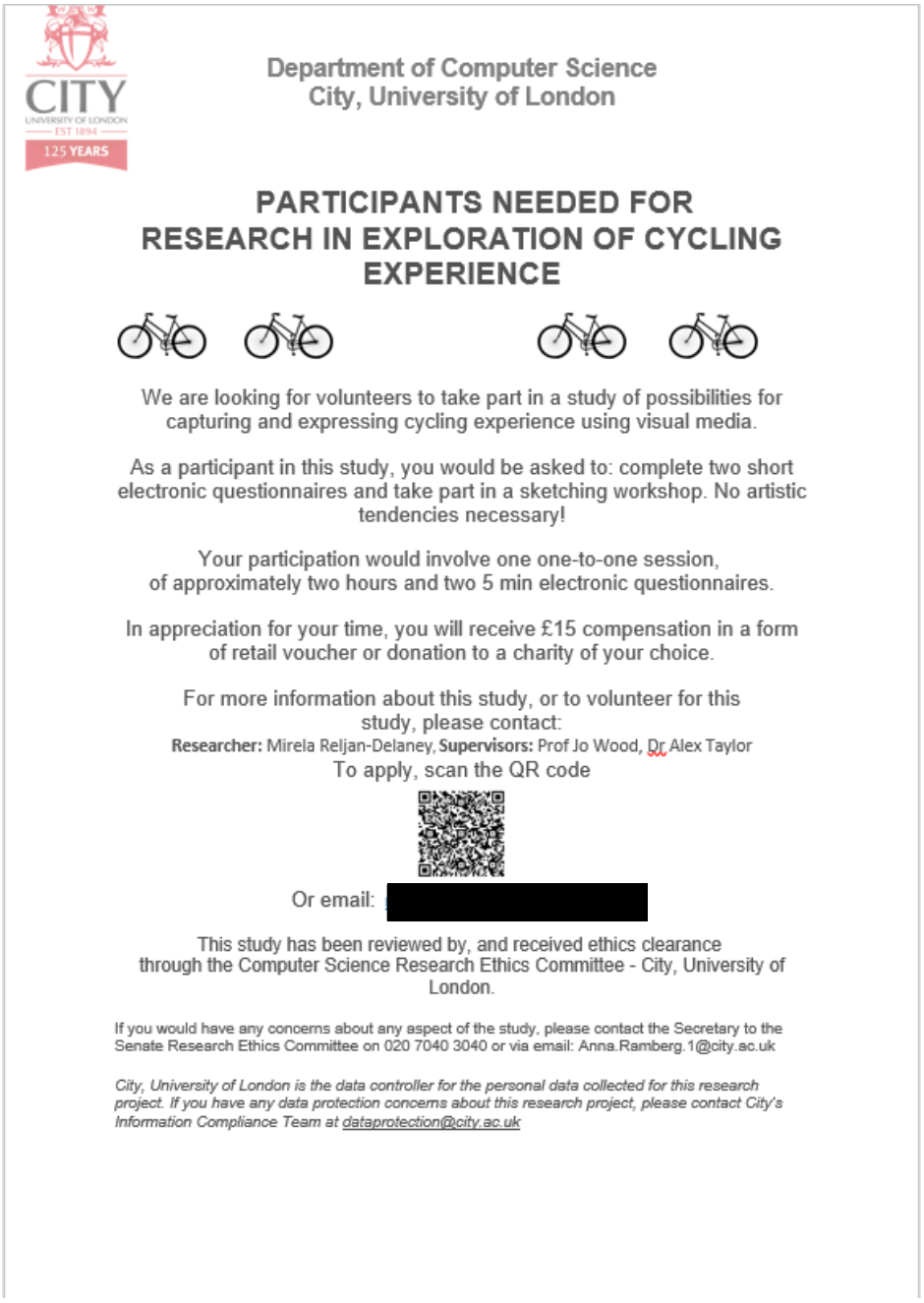
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.1.3 Recruiting Poster for the First Study



Department of Computer Science
City, University of London

PARTICIPANTS NEEDED FOR RESEARCH IN EXPLORATION OF CYCLING EXPERIENCE

We are looking for volunteers to take part in a study of possibilities for capturing and expressing cycling experience using visual media.

As a participant in this study, you would be asked to: complete two short electronic questionnaires and take part in a sketching workshop. No artistic tendencies necessary!

Your participation would involve one one-to-one session, of approximately two hours and two 5 min electronic questionnaires.

In appreciation for your time, you will receive £15 compensation in a form of retail voucher or donation to a charity of your choice.

For more information about this study, or to volunteer for this study, please contact:
Researcher: Mirela Reljan-Delaney, **Supervisors:** Prof Jo Wood, Dr Alex Taylor
To apply, scan the QR code

Or email: [redacted]

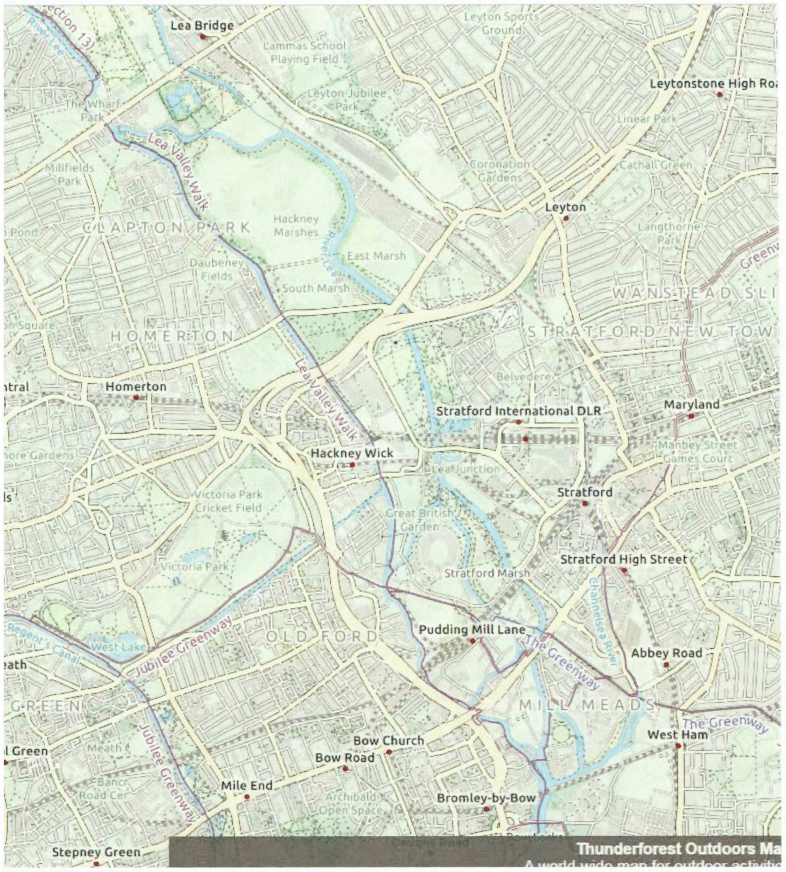
This study has been reviewed by, and received ethics clearance through the Computer Science Research Ethics Committee - City, University of London.

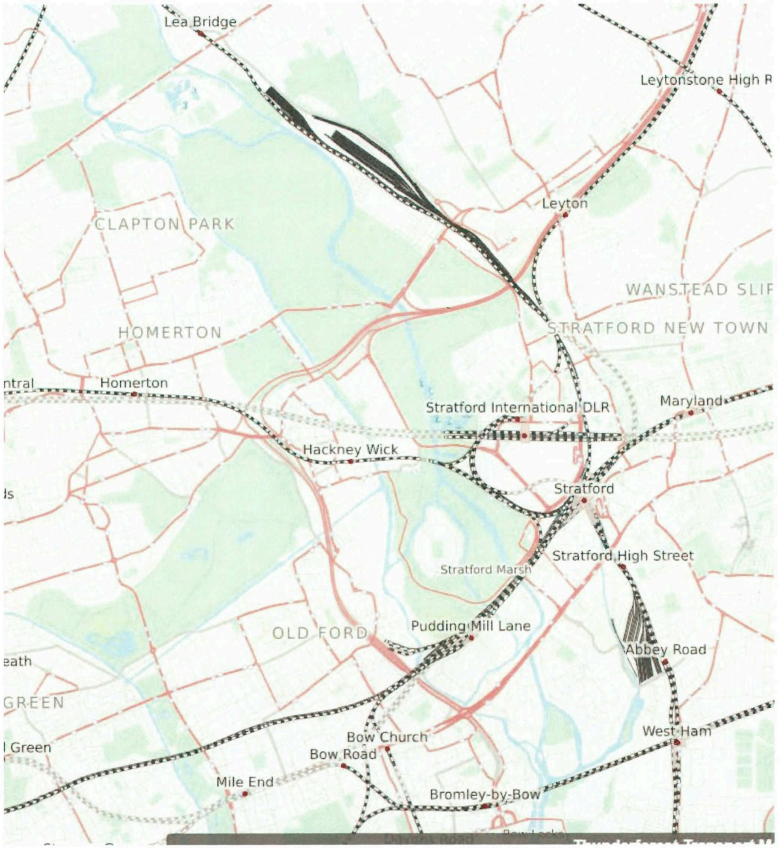
If you would have any concerns about any aspect of the study, please contact the Secretary to the Senate Research Ethics Committee on 020 7040 3040 or via email: Anna.Ramberg.1@city.ac.uk

City, University of London is the data controller for the personal data collected for this research project. If you have any data protection concerns about this research project, please contact City's Information Compliance Team at dataprotection@city.ac.uk

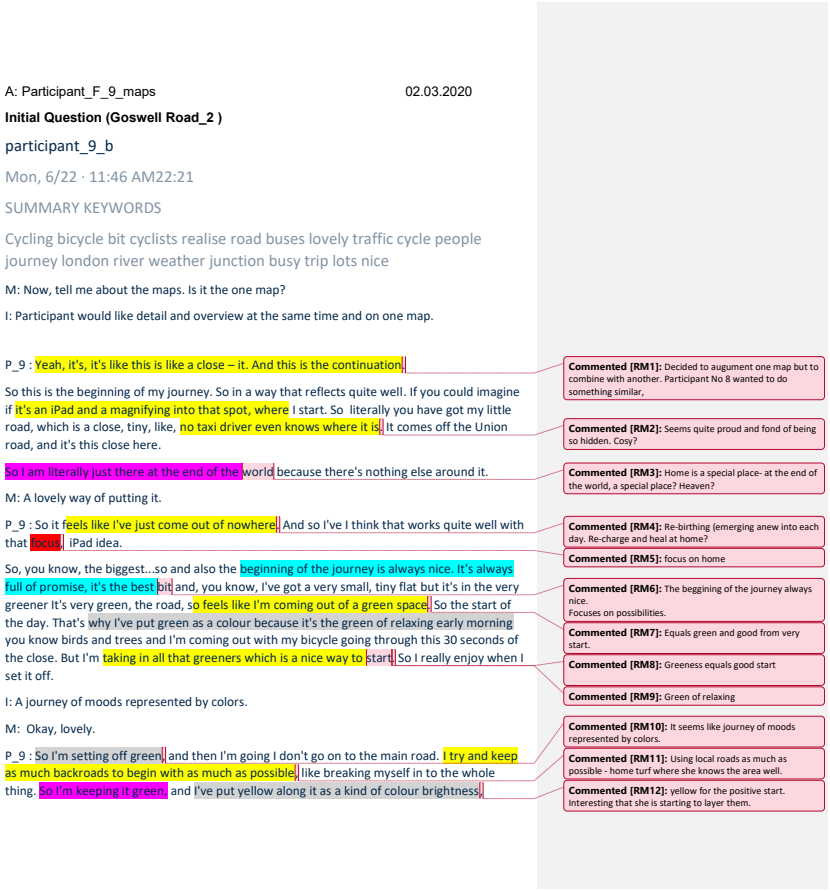
.1.4 MAP TYPES - STUDY ONE

CUSTOM MAP WITH ONLY LINES CUSTOM MAP WITH LINES AND NAMES CUSTOM MAP WITH LINES AND GREEN AREAS


Lea Bridge
Leyton Sports Ground
Lammas School Playing Field
Leyton Jubilee Park
Leytonstone High Ro
The Wharf Park
Linear Park
Lea Valley Walk
Coronation Gardens
Cathall Green
Millfields Park
Leyton
CLAPTON PARK
Hackney Marshes
Langthorne Park
River Lea
East Marsh
Daubeney Fields
South Marsh
WANSTEAD SLI
HOMERTON
STRATFORD NEW TOW
Homerton
Belvedere
Stratford International DLR
Maryland
Hackney Wick
Manbey Street Games Court
Lea Junction
Stratford
Victoria Park Cricket Field
Great British Garden
Stratford High Street
Victoria Park
Stratford Marsh
Channelsea River
Pudding Mill Lane
Jubilee Greenway
West Lake
OLD FORD
The Greenway
Abbey Road
MILL MEADS
The Greenway
West Ham
Bow Church
Bow Road
Mile End
Bromley-by-Bow
Stepney Green
Thunderforest Outdoors Ma


Lea Bridge
Leytonstone High R
Leyton
CLAPTON PARK
WANSTEAD SLIF
STRATFORD NEW TOWN
HOMERTON
Homerton
Stratford International DLR
Maryland
Hackney Wick
Stratford
Stratford High Street
Stratford Marsh
OLD FORD
Pudding Mill Lane
Abbey Road
West Ham
Bow Church
Bow Road
Mile End
Bromley-by-Bow

.1.5 An Example of Transcribed and Coded Interview for the First Study



A: Participant_F_9_maps 02.03.2020

Initial Question (Goswell Road_2)

participant_9_b

Mon, 6/22 · 11:46 AM22:21

SUMMARY KEYWORDS

Cycling bicycle bit cyclists realise road buses lovely traffic cycle people journey london river weather junction busy trip lots nice

M: Now, tell me about the maps. Is it the one map?

I: Participant would like detail and overview at the same time and on one map.

P_9 : Yeah, it's, it's like this is like a close – it. And this is the continuation.

So this is the beginning of my journey. So in a way that reflects quite well. If you could imagine if it's an iPad and a magnifying into that spot, where I start. So literally you have got my little road, which is a close, tiny, like, no taxi driver even knows where it is. It comes off the Union road, and it's this close here.

So I am literally just there at the end of the world because there's nothing else around it.

M: A lovely way of putting it.

P_9 : So it feels like I've just come out of nowhere. And so I've I think that works quite well with that focus. iPad idea.

So, you know, the biggest...so and also the beginning of the journey is always nice. It's always full of promise, it's the best bit and, you know, I've got a very small, tiny flat but it's in the very greener It's very green, the road, so feels like I'm coming out of a green space. So the start of the day. That's why I've put green as a colour because it's the green of relaxing early morning you know birds and trees and I'm coming out with my bicycle going through this 30 seconds of the close. But I'm taking in all that greeners which is a nice way to start. So I really enjoy when I set it off.

I: A journey of moods represented by colors.

M: Okay, lovely.

P_9 : So I'm setting off green, and then I'm going I don't go on to the main road. I try and keep as much backroads to begin with as much as possible, like breaking myself in to the whole thing. So I'm keeping it green, and I've put yellow along it as a kind of colour brightness.

Commented [RM1]: Decided to augument one map but to combine with another. Participant No 8 wanted to do something similar,

Commented [RM2]: Seems quite proud and fond of being so hidden. Cosy?

Commented [RM3]: Home is a special place- at the end of the world, a special place? Heaven?

Commented [RM4]: Re-birthing (emerging anew into each day. Re-charge and heal at home?

Commented [RM5]: focus on home

Commented [RM6]: The beggining of the journey always nice.
Focuses on possibilities.

Commented [RM7]: Equals green and good from very start.

Commented [RM8]: Greeness equals good start

Commented [RM9]: Green of relaxing

Commented [RM10]: It seems like journey of moods represented by colors.

Commented [RM11]: Using local roads as much as possible - home turf where she knows the area well.

Commented [RM12]: yellow for the positive start. Interesting that she is starting to layer them.

because you know, always, it's not the case often. I always think it's a bright early sun or something, you know, when you, start of your day. So I'll you know, that's kind of how I'll go because it's the brightest bit of the day and it is the nicest bit of the day, and you're excited for the day.

M: Yeah.

I: Is High alert a problem as we use cycling as a type of meditation and we don't like that to be taken away from us?

P_9 : But then once I come to a little bit here, I have to go into the Clapham Road, which is the . busy trafficy road going from Stocklwell over to Oval. Then there I have to pay attention. So you've got some red exclamation marks along the side. Now here you can't be dreamy. You've gotta, you gotta, you know, there's no separate cycle path. There's those blue ones, but they're not...(there is) lots of other cyclists, which is good. I like the company of other cyclists. They the ones that just painted that are not separated.

M: Oh, okay. Okay.

P_9 : Under Boris Johnson! Blahhh!!!! (high distaste for the current PM) (laugh) When he was a mayor, yeah.

P_9 : So they are fake. Really, they're more dangerous because, you know, they make you think you're in your cycling spot, but they're usually a shared space. So the red is basically exclamation marks indicate attention needed. Lots of cars, lots of traffic.

So I go all the way along down this road. So here I pop out and here we go into the small map. So as I go into the small map, and here I pop out, still continuing with this very busy red area here. So again be, you know, need to be very vigilant along this road. Then I come to a junction and everyday, even though I've been doing this for a while, I always have to decide whether to go left or whether to go right so here's my decision point. So that's a question mark there. It's a busy area. And I always need to think, what; should I go left or should I go right ? Now, I always go left. But I've noticed that my decision basically depends a lot on how many buses there are. And usually there are lots of buses on the right on the right bit and that puts me off. I don't want to be fighting with the buses for my cycling space. So, Ill go left because that's the easiest one without a bus and it has a little cycle route into the left bit, then the busses start coming to that one as well. But at least it gets me in there. So here I've got question mark and a decision point and the red buses, I carry along there, again, a red area, really lots of junctions have to be really careful. There is no cycling space as such, so have to be super careful along this this road here.

I get to the Imperial War Museum, and at the Imperial War Museum I have to turn right but there are incredibly long traffic lights there. So I take the opportunity to do my eye exercises. My Bates eye exercises, you know, to stretch all the muscles. So I sit, I'll be on my bike for five

Commented [RM13]: Pay attention, high alert a problem.

Commented [RM14]: Red and exlemation marks for alertbess

Commented [RM15]: Existing cycle infrastructure inadequate.

Commented [RM16]: Calling some current cycling infrastructure fake and more dangerous than having none at all.

Commented [RM17]: Pop out, like she is ejected with force. Nothing coutios or slow.

Commented [RM18]: A decission point. Identified.

Commented [RM19]: Decission point.

Commented [RM20R19]: Now she always goes left? Why has to think? is it in the past that she took the route at different time and went right? What is on the right that is attractive?

Commented [RM21]: Heavy vehicle presence determins the route.

Commented [RM22]: Red area = lots of junctions

Commented [RM23]: Doing eye exercises at the traffic lights. Advantage od not CHANGING ROUTE you can build things in!

minutes doing these exercises, and it's always there that I'm doing them. Like just every time I'm doing my exercises as I have such a long wait and a long stop at these lights.

I: Calling some current cycling infrastructure fake and more dangerous than having none at all.

I: Advantage od not CHANGING ROUTE you can build things in! Such as eye exercises.

M: That's interesting.

P_9 : You got to use all your time

M: I know!

P_9 : (laughing) So, this is the good time to do it, eye exercises! People looking at me rather peculiarly.

And then I start going on to a nicer bit which is basically just all cycle lane. Which is great. It's lots of cyclists but it's you know you're much more comfortable if you're gonna get knocked over by a cyclists, them by a big juggernaut.

I: Level of danger. Still not safe as a lot of cyclists and one supposed different speeds and abilities, plus temperament. But much less damage if hit.

P_9 : So here I really start relaxing, and here I'll probably stop to plugg into music. I've got musical notes there. So when listening into my music, I'm not a fast cyclist, but I'll go steady pace, listening to my music and all the way up all along through the Sadock up to Blackfriars bridge. Blackfriars bridge, super busy, lots of cyclists, lots of cycling traffic there. But you're going across the river, which is lovely listening to the music. And, you know, and that again, you have to be careful because they keep coming across, you know, you have to change junction, but nonetheless a nice thing.

I: Crowding mitigated by safety and scenery. Super busy but still nice as river and landscape.

P_9 : I get over Blackfriars Bridge, go a bit further down, and then I have to turn. I turn right and I go through Smithfield market to then cur across, to come out to come here to Northhampton Square. And the things that from there is I go through the market, so it's a very strong smell of dead meat. So very fleshy, bloody smell. Yeah. And that's, um, yeah, so but I always got that strong smell.

I: Smell a factor im cycling expirience. However, she does not change the route.

M: Yes, my husband works near the at Faringdon. Building Crossrail.

P_9 : Well, they are building the new Museum of London next to there?

M: Yes.

P_9 : And also, um, that bit... for some reason there's a little steep hill and I always find that

Commented [RM24]: Cycle lane great despite being full of cyclists and very busy.

Commented [RM25]: Threat still there but less acute and severity of demage less.

Commented [RM26]: Crowding mitigated by safety and scenary.

Commented [RM27]: Language has changed. She does not pop out, she comes out.

Commented [RM28]: Smell a factor in expiriencing journey.

quite hard work. Yeah, it's like the hardest bit. It's just literally one minute but yeah, the hardest bit of my journey.

M: Okay. Is that the hill?

P_9 : Yeah. And, that's blood. From the meat

This is kind of...it's not a hill. It's just like, suddenly a steep road and it's quite an uncomfortable steepness, because you have to deal with the traffic and go up.

M: Yeah. Okay. Fantastic.

Sketch ----------

M: And the, the picture?

P_9 : Okay, so um, yeah. So basically

my bicycle for me is freedom to travel. You know, I see people stuck in caaaaars (exagareted and elongated as she is mocking them), they may be in a fancy caaaar, maybe at the traffic lights, they may zoom off. But you know, give it five minutes later I'm going past them, you know?

I: Feels like has an upper hand as not influenced by traffic jams.

P_9 : It gives me control of time because I, you know, I don't like wait for a train and there's a delay. I'm in control of that. So you know, if I say I'm going to be somewhere at nine o'clock, I am usually there at nine o'clock you know, very rarely late for things, I think. Compared to people who travel by train. So I've got that freedom.

Uh, for me, it gives me, even though, you know, even though I'm not setting out to get physically fit with that, but if I feel it gives me it does make me stronger. And, you know, that's, you know, that's a definite plus. Because I just, I don't realise it but then I do realise actually that I've got really strong legs. But that's like 25 years of cycling Oh, yeah, that's strong legs there. Yeah.

And I you know, I really love the idea that I can do my own thing I can listen to my music and while looking at some, you know, looking at the river going by, you know, maybe not necessarily on this trip but often going by the Houses of Parliament and you know and seeing trees and just getting a bit of that sort of daylight going in and that for me is a really lovely thing to do.

I: tuning in with the surroundings.

P_9 : Other aspects obviously, it's all of this, which is like over the horizon though. There is the danger of traffic that is a real issue which I think is in many ways unfair it shouldn't be like that. I think cyclists, Oh, well, pedestrians, most of all, but cyclists and pedestrians I think we should have priority frankly. I don't think, I don't think the sense of you know, the sense of entitlement that I sometimes get, particularly from professional drivers like taxi drivers or van drivers. I really... (can't find the words)

M: Yes.

S_9 : So there's a quite strong anti cycling culture. So I've had like water thrown in my face and yeah, like yeah, yeah. You know, because even looks of pure hate. It's people don't like cyclists,

Commented [RM29]: Steep hill. Short but steep gradient and hardest bit of the journey.

Commented [RM30]: Blood to represent the meat smeel.

Commented [RM31]: bycicle equals freedom.

Commented [RM32]: Feels like has an upper hand as not influenced by traffic jams.

Commented [RM33]: Control over time.

Commented [RM34]: Physica fitess not primary objective but definite benefit the participant is aware of.

Commented [RM35]: Doing their own thing.

Commented [RM36]: In tune with the environment. Or tuning in with the surroundings.

Commented [RM37]: Importance of daylight, understated.

Commented [RM38]: Intimidated by traffic, especially professional drivers.

Commented [RM39]: Feels that there is a strong anty-cycling culture on the roads.

some people are just, just crazy. They just wanna sit in their car. And they don't. So there's that real that's a real thing, actually . And I'm very aware of that.

I: Feels that there is a strong anty-cycling culture on the roads.

P_9 : Most of the all weathers I mean, I hardly at you know, unless it's really chopping it down. nothing particularly stops me so I'm not very well prepared. I don't have all that...nah. But um, you know, I will go through even if there's a bit of a rain of rain on here, but it's actually quite rare comparatively because people always say, oh, how can you do with English weather? Actually it doesn't rain that often? It doesn't.

I: Weather quite low down the list of things to consider and not an obstacle. A British born participant.

P_9 : Its gray, but it does not rain as much as people think. .

M: Okay, thank you. I got a few questions I need to go through this is all wonderful, truly, truly wonderful. list of questions we didn't do very well.

P_9 : Oh, good because yeah, I'm gonna have to go soon. I think.

M: you got ten minutes.

P_9 : Oh, wow. Okay. Oh, come.

Commented [RM40]: Very aware of the tension with motorised vehicles drivers.

Commented [RM41]: Cycling in all wether but it does not rain that often.

Commented [RM42]: Does not mind gray.

A: Participant_F_9_questions 02.03.2020

Initial Question (Goswell Road_2)

M: **So, when you cycle, on average, how many destinations you do is in a day? Y**ou might have certain days that the ,you usually visit this many destination with different type of day you can visit the different number of destination

P_9 : Let's say maybe two or three.

M: **What is the purpose of the trips ?**

M: Yeah, well work obviously. Mm hmm. shopping. Visiting my mother.

M: **Can you associate a word with each of those trips?**

P_9 : Okay, work is long. (laugh)

Shopping is handy because I can also put the weight into my basket. Yes, I can actually bring quite a lot back. And it's quick.

Visit visiting my mother again. Yeah, that's really quick. It's yeah, quick.

M: **And what is your favourite journey?**

P_9 : Oh, I did a lovely journey (sudden, fond remembrance) , but I yeah, I did a lovely journey the other night and I was thinking what a wonderful journey it is. it's not one that I do regularly. I yes I visit, I met up with a friend of Victoria.

Was it Victoria? And then we went to, and we ate something, then I had to come back and it was already a bit dark, not very dark, a bit dusky and I cycled back through Pimlico, along the river, and I remember thinking oh my god, this is such a lovely, yes such a lovely cycling trip. Yeah. Are you sure it was that one? Or was like when I went to Trafalgar Square, anyway one of those . And the river I think mainly I really like it when I can go along the river.

I: Does not remember the location but remembers the purpose and the surrounding.

M: **That partly answers my next question what makes this experience stand out?**

P_9 : Okay yeah um yeah what's like I think it's quietness in a very busy place but you can be... You know? You can, you can enjoy the senses. Without being overwhelmed so if you're like on a train or on the bus, it can be a bit over I find it a bit overwhelming, but with the bicycle because you're sort of in your own space, but yet you're going through this incredible incredibly overstimulating space but you can observe and take in your surroundings, you know, ; or views; or the river; or the weather or the dark, you know, it basically interesting.

M: **When you choose cycling of other modes of transport, what motivates this decision?**

Commented [RM1]: Shopping by bicycle quick.

Commented [RM2]: Does not remember the location but remembers the purpose and the surrounding.

Commented [RM3]: You can take in your surondings Suroundings worth taking in?

P_9 : Quick! usually quick and I'm not that keen on, I don't like walking very much. (laughs) I rather got my bicycle.

M: **Did you manage to capture things that matter to you in in in your in your two outputs?**

P_9 : Yeah, I mean, for the moment, you know? Maybe if you ask me tomorrow, I might come up with something completely different, but I think the idea of freedom, the idea of the physical impact, the idea of being able to see the views, to kind of you know, go work through the senses I think there's more of a sense related there. The idea of control of time is very important to me the things that really annoy me or the you know, the things that I've I'm feel quite strongly about, so I do tweet a lot about it as well as anty-cycling culture. So I do follow like come at you know, campaigners cycling organisations and you know, and try and support them and re-tweet them and everything. And also in terms of the, you know, the dangers of traffic. That's obviously just something that, you know, we really need to work on as society overall. The idea that the weather, you know, is obviously important because that kind of affects your whole sort of mood as well as your decisions as well as your day. I always have. I always am looking at the weather. Thinking, can I and if I can't, then it's bugging my day basically, that means that I have to take the underground which is a nightmare. And then I'm always late.

Commented [RM4]: All the things that matter to them most relating to cycling.

Commented [RM5]: Wether affects your mood, decissions and day! Love this person. Puts her finger on it!

M: This is such a lovely way of putting it.

P_9 : I can see that's going to be a quote.

M: Definitely. (both laugh)

M: **In general, what makes cycling difficult?**

P_9 : Cars. (Very definite.) Other cyclists as well? (sort of surprised) Oh yeah, anty-cycling culture there is I think and I know you are vulnerable, you're vulnerable not only to be knocked over by a car because obviously they're not doing it on purpose. But what really made me think about that was when I someone came and through water in my face, it could have been anything.

M: Must of been so scary.

P_9 : Well, I didn't realise what it was. Yeah. Just thought, bloody hell.

M: **And you managed to capture that in our drawings?**

P_9 : Well, it's the no cycling culture, yeah, yeah. I'm gonna put like the kind of splashing water to remind you.

Okay, I'm 30 I'm not taking account

M: **In your usual trip. Do you change your route?**

P_9 : Sometimes, sometimes.

M: Okay. **When you do. What is the reason for that?**

P_9 : Usually to avoid traffic.

Or we even just change a scene because I get stuck. Like this one I've been doing now for a while I might actually start looking something different just to change the scene of it.

M: **Did the material provided help you express what is important?**

P_9 : Well maps are good. Yeah, my map I'm not I don't have a good sense of direction and that's the thing that actually bicycle has given me is knowing where things are because I think you know, I grew up in London as a teenager I didn't know any idea where things were I just got on the underground and got out. Didn't realise the distances that place the bicycle I realise how close things are.

M: **But did it limit you? Do you think it limited you what we gave you?**

P_9 : I mean, maybe if I, if you said draw a map of where you cycle I might have done something more scematic, you know, like a London Underground thing, you know more of an illustration rather than a distance generally. Yeah, yeah, maybe in that sense I could have I would have maybe created like a mind map kind of set up even, you know, things that are more important closer to each other things are not as important or as not as nice or not as or more difficult could have been further you know, yes. You see, I'm saying like the even though I made here, it's actually a tiny little road compared to all this. But here I find that the most difficult bit like well, maybe I would have made that longer or bigger to indicate that it's the hardest bit of the journey.

M: **And last but not least, did you arrive to any insights during this session?**

P_9 : Okay, um, um, probably that what I probably really enjoy about cycling is more the senses aspect of it. I, you know,

I suppose because, you know, I do find a lot of things quite stressful about living in London, and that, for me is a real relief for me to be able to move and function in London. But on my bike, I wouldn't I don't think I would be at all well, otherwise.

M: Okay. So, is that mental health?

P_9 : I think so. Yeah, man. Yeah. I think both mental and physical health. Yeah, yeah, definitely. I think I'd really suffer. If I had to commute every day. I'll probably be used to it, but I am sure it would have a big impact on my on my quality of life.

Okay, that's wonderful.

Thank you. Okay. Really, really wonderful.

Commented [RM6]: Changes route to dispell routine, but she has been living in London a long time. It sounds like her whole life. Knows the city,

Commented [RM7R6]: How things relate to each other.

Commented [RM8]: Bicycle has put her more in touch with her surroundings and situauted her in the city.

Commented [RM9]: Very good but she could have done this in the sketch. Thought of it later?

Commented [RM10]: Cycling directly responsible for mental wellness and helath. Crutial for functioning.

.2 STUDY TWO

.2.1 STUDY TWO WORKSHOP PLAN

Study title: Qualitative Visualisation: Friction and Flow in Everyday Life of Cyclists
REC reference: ETH1920-0753: Mirela Reljan-Delaney (Low risk)
Researcher: Mirela Reljan-Delaney, mirela.reljan-delaney@city.ac.uk
Supervisors: Prof Jo Wood, J.D.Wood@city.ac.uk, Dr Alex Taylor, alex.taylor@city.ac.uk

Workshop Plan

This is a breakdown of the workshop titled ' Qualitative Visualisation: Friction and Flow in Everyday Life of Cyclists'. The aim of the workshop is to access higher-level motivation for cycling and the role of maps in facilitating self-reflection and aiding self-reflection and to examine their choices of self-expression.

Friction and Flow in Everyday Life of Cyclists Workshop	
Delivery mode	Integrated workshop/interview
Location	City, University of London
Type of interaction	One-to-one
Type of workshop	Paper study – participants will be asked to augment and draw maps using materials provided
Type of interview	Semi-structured. While there is an overall aim, the exact questions will partially depend on the participant's output.
Materials for participants	• Range of maps, including aerial satellite images, cycling maps, road maps with different granularity and features and maps accentuating green spaces. • Blank paper. • Post-it notes. • Marker pens in a range of colours. • Pencils in a range of colours. • Play doh. Pilot has shown that some participants prefer to accentuate things by rendering them in 3D. • Writing pens. • Writing pencils.
Materials for the researcher	• Electronic tablet/laptop. • Copies of information sheet. • Paper copies of the consent form. • Notepad and pen for taking notes. • Mobile phone for recording of the interviews. • Incentive voucher. • Refreshments to offer participants.

.2.2 STUDY TWO ETHICS PROPOSAL

Qualitative Visualisation: Friction and Flow in Everyday Life of Cyclists

Risks

R1) Does this project have funding?
No

R2) Does the project involve human participants?
Yes

R3) Will the researcher be located outside the UK during the conduct of the research?
No

R4) Will any part of the project be carried out under auspices of an external the organisation, involve collaboration between institutions or involve data collection at an external organisation?
No

R5) Do your projects involve access to, or use of, material that could be classified as security sensitive?
No

R6) Does the project involve the use of live animals?
No

R7) Does the project involve the use of animal tissue?
No

R8) Does the project involve accessing obscene materials?
No

R9) Does the project involve access to confidential business data (e.g. commercially sensitive data, trade secrets, minutes of internationals meetings)?
No

R10) Does the project involve access to personal data (e.g. personnel or student records) not in the public domain?
No

Project Details

P1) Project title
Qualitative Visualisation: Friction and Flow in Everyday Life of Cyclists

P1.1) Short project title

.2.3 Study Two - Qualtrics Surveys (Show of Interest and Recruitment)

The welcome page of the show of interest survey is shown to display text: "Default Question Block". This is an idiosyncrasy of the Qualtrics download mechanism and was not present in the interactive version. The same is true for the text displayed on the welcome page of the consent form which reads: "CONSENT FORM".

Default Question Block



Thank you for your interest.

We are researchers from the City, University of London and our aim is to further understanding into ways that the cycling experience is communicated. One of the great things about cycling is that is an activity that has a broad take-up and is accessible to many. In order to have a representative sample, applicants are asked to fill in this 2-minute survey.

We understand that people's routines have changed in the last year and a half and there is no right or wrong answer.

This study has been reviewed by and received ethics clearance through the Computer Science Research Ethics Committee - City, University of London. If you would have any concerns about any aspect of the study, please contact the Secretary to the Senate Research Ethics Committee on 020 7040 3040 or via email: Anna.Ramberg.1@city.ac.uk

City, University of London is the data controller for the personal data collected for this research project. If you have any data protection concerns about this research project, please contact City's Information Compliance Team at dataprotection@city.ac.uk

Block 2

Have you got a online-meeting capable device (camera and microphone), such as laptop or table and a internet speed that can support such meeting?

- ○ Yes
- ○ No

In order to contact you, we need you to provide us with an email address. If you have any issues with this form, do not hesitate to contact me on [redacted]

Do you agree to the anonymised answers from this form to be used for collating the data regarding the response to the recruitment for this study?

- ○ No
- ○ Yes

Have you been cycling **before** the COVID-19 prevention measures came into place?

- ○ Yes
- ○ No

Have you been cycling **since** the COVID-19 prevention measures came into place?

- ○ Yes
- ○ No

Are you 18 or over?

- ○ Yes
- ○ No

Do you consider yourself to be (you can choose more than one option):

- [ ] Occasional cyclists
- [ ] Commuter
- [ ] Beginner cyclist
- [ ] Competitive cyclist
- [ ] Cycling for leisure
- [ ] Daily cycling

What is your age?

- ○ 18 - 30
- ○ 30 - 50
- ○ 50 - 70
- ○ 70 +

What gender do you identify as?

- ○ Male
- ○ Female
- ○ Non-binary / third gender
- ○ Prefer not to say

How would you describe your ethnicity? (this question allows multiple answers)

- ○ European
- ○ British
- ○ Asian
- ○ African
- ○ European
- ○ Black
- ○ White
- ○ Mixed origin

- ○ Rather not say
- ○ Other

Powered by Qualtrics

English (United Kingdom)

CONSENT FORM

Welcome to the Cycling Experience research study!



We are delighted that you are willing to participate in this study. In order to make sure that your decision is informed one, we would like you to carefully read and fill in the following consent form.

We hope that you will find participating in this project fun and the reflective aspects beneficial.

All the information provided will be treated with the highest degree of confidentiality as stated in the Participant Information Sheet.

We would like to remind you that participation is voluntary and that you can withdraw (partially or fully) at any stage without being penalised or disadvantaged in any way.

If you don't hear from us immediately, don't worry. We are hard at work and the responses are monitored. We will respond to all applicants within a two day period.

I confirm that I have read and understood the participant information dated 08/08/2021 for the above study. I have had the opportunity to consider the information and ask questions which have been answered satisfactorily.

- ○ Yes

I understand that my participation is voluntary and that I am free to withdraw without giving a reason and without being penalised or disadvantaged.

- ○ Yes

I understand that I will be able to withdraw my data up to the time of publication of any academic work that results from this study.

- ○ Yes

I agree to the workshop and the interview being recorded.

- ○ Yes

I consent to the reuse of research data in other studies. Any reuse would be strictly limited to studies that have received ethics approval.

- ○ Yes

I consent to de-identified records of interviews, including audio, video and transcripts of such, as well as session outcomes being kept by the researcher and used in presentations and publications in academia, teaching and for the wider public.

- ○ Yes

I consent to use of anonymised direct quotes.

- ○ Yes

I understand that data will be shared with the research team.

- ○ Yes

I understand that the anonymised data will be made open access in order to underpin academic publication.

○ Yes

I agree to City recording and processing this information about me. I understand that this information will be used only for the purpose(s) explained in the participant information and my consent is conditional on City complying with its duties and obligations under the General Data Protection Regulation (GDPR).

○ Yes

I agree to take part in study.

○ Yes

Please insert your email address in order for us to contact you.

Demographic and Attitudinal Questionnaire

Thank you for your consent.
You have been amazing and we know that surveys can be trying but it would be helpful if you could answer a few few short questions regarding attitude to cycling?
This part of the form takes 2 min (we checked).

What is your profession?

How long have you been cycling? (Give an answer in years.)

How long have you been cycling in UK? (Give an answer in years.)

If you are parent, or a carer , what proportion of your overall cycling do you cycle with children? (either using a child-seat or accompanied)

- Most of my cycling is with children
- Just some of my cycling is with children
- I don't cycle with children
- Other

In a couple of words, what is important to you about cycling?

In a couple of words, what makes cycling difficult?

Do you use navigational tools in relation to your cycling?

- Yes
- No

Do you find the visual representations of your environment relate to your perception of environment as a cyclist?

- Yes
- No

What significance cycling has as mode of self-expression ?

- Extremely significant
- Very significant

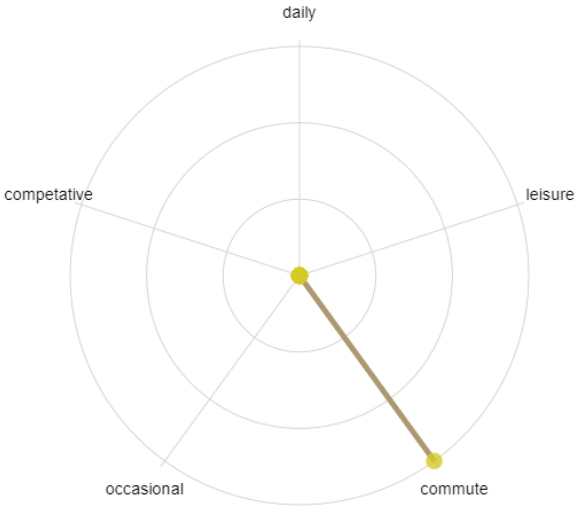
- ○ Moderately significant
- ○ Slightly significant
- ○ Not significant at all

Please use this space if you wish to elaborate any of the answers or make any additional comments.

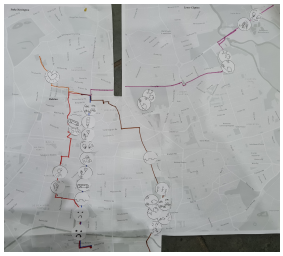
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.3 The Remainder Study Two Analysis (Participants 5 - 12)

Participant Five - P5



P5 visual stamp



P5 mapping

Table .3.1: [P5- Study 2]Visual stamp of self-identified cycling activity and an example of output Participant Five has created.

- **Gender:** Female
- **Age:** 50-70
- **Profession:** Ceramic artist
- **Ethnicity:** White
- **Importance of cycling for self-expression :** Moderate

Abstract This participant has heard about the study on the social media platform. She is a local craftsman/artist and her cycling is an embodiment of 15 min city existence [247] as she does not use the bike for longer rides. She is a cautious rider and prefers quiet roads for various reasons (safety and social interaction). However, she has started changing her cycling habits. The change is due to the combination of the addition of new work commitments, resulting in a time constraint, and her improved cycling confidence. Her cycling is affected by changes in her work and is characterised by commuting to various locations.

Introduction

"*I never leave Hackney*"

This is a person who travels a lot locally. As an artist, her main journey is between her home and the studios where she works. At the outset, she wanted to communicate her unease around traffic.

"*I would generally try to keep off main roads when I cycle...I am wary of cars.*"

However, with the frequency of journeys, her confidence is increasing. Also, her practice has changed and she has started working at two places, hence she has less time to travel and to use the quieter route that takes longer.

Conflict - "Every route has a story" ***Route One - Overcoming difficulty***The participant started the interaction with maps by discussing the busier road that she prefers less and that causes her more friction. However, this is the route she is increasingly taking due to a combination of the escalation in her workload and increased cycling confidence. She describes *cycling infrastructure* that seems to be uneven and full of *potholes* that force cyclists closer to the traffic. It is a busy road full of *cars, buses* and *other cyclists*. While the professional drivers (bus) seem not to cause friction, the participant has a love-hate relationship with *other cyclists*.

"*I think there are lots of other cyclists who are very inconsiderate and just do things that are not good for them, and not good for other cyclists and not good for the promotion of cycling.*"

In her narrative, thoughtless cyclists hold more significance than other types of road users who behave inappropriately.

Like the P1, she has created a token for *anxiety* as she finds this area very stressful. This seems to be in large part due to the amount of traffic combined with the type of infrastructure that she considers unsafe. Another factor contributing to her unease is awareness of historic injuries that have been reported, or that she has witnessed, on the route.

Route Two - "Safety"

"*And that is the route I used to use all the time. I feel much safer as it is one of the designated Quiet Routes. "*

This is the alternative route previously described and is the preferred route to one of the studios where this participant is working. It used to be the main daily commute before she took on managing another studio and her workload doubled.

The route is her favourite as she feels safe and relaxed. While she generally associates independence with cycling, she is aware of it more here. One of the factors that make the route relaxing is the absence of *other cyclists* (in addition to generally reduced traffic).

Talking about about this route, and examining it, has led to thoughts regarding her progress in cycling, her attitude to cycling and why this is her preferred mode of transport. *Independence* and control have been stated as the main drivers. When cycling, she is not dependent on the transport timetable or affected by traffic.

"*When you cycle, you know how long it will take.*"

This enables her to plan her day better and to have a greater influence on timing. She has expressed that the use of her bicycle has increased as has her confidence.

Orientation - Route Three - "Family bonding time"

Social cycling is not the primary cycling activity for this participant but it is the one with a clear positive connotation. This is supported by the participant's use of tokens as she has only used *joy* on this route. She describes her cycling with the family in a very warm and straightforward way. She does not recount the surroundings but the feeling and the relationship.

This route is very local and she uses it to take her child to a swimming lesson. The child does not cycle independently and she takes them on the back of her bike. The main impetus for the activity seems to be expediency, as she states that she does it to get them there "*More quickly.*" However, the time is utilised for family bonding as it gives them an opportunity to talk.

"*...we'll just be chatting away about whatever, you know, what is going in their mind. I just thought I would put a little joy sticker because it is such fun talking to them about what is going on in their life. Sometimes I will talk to them about what is going on with me. "*

At the end of this section, she mentions cycling with her husband during the lockdown. She does not go into detail but implies that those trips were akin, in some aspects, to the swimming lesson journeys, by linking them in the same section of narrative.

Route Three - "Abandoned track" - Evaluation

"*I used to like this route*"

This participant's work is based at several locations. One location is reached by the first two routes she has described. The other location is in the London Borough of Waltham Forest. This is significant as Waltham Forest is one of the three London outer boroughs taking part in a pilot for cycling infrastructure transformation called 'Mini Hollands'. Mini Hollands, as their name suggests are based on a Dutch model, aimed at improving cycling conditions and promotion of cycling in areas that have previously reported low engagement in active travel [128], [112]. The participant hails the infrastructure as the ideal setting for cycling due to segregated paths. However, the crime reports, combined with the 'out of hours' work that an artisan potter is sometimes required to do, led to the participant using other modes of transport that left her less exposed and vulnerable (driving).

At the end of the section, she compares her driving experience with cycling and is explicit that the area is car-congested and cycling would be a better option, but personal safety concerns override both comfort and expediency.

Route Four - Resolution

"*This is the one where I interact with people the most.*"

The last route the participant has described is also a commute but one with less

friction. She describes a leisurely ride interrupted by a bad crossing and pedestrians in the park (both mentioned also by P1). However, despite difficulties with shared infrastructure, she likes the park as it is green and she finds observing people interesting.

She has expressed an opinion that the last section of this route has increased traffic as a consequence of traffic reduction measures, like LTNs. She experiences cycling there as more intimidating due to the congestion. The worsening conditions seem to affect drivers' tempers and focus. She feels cautious and wary in those areas to the degree that sometimes she gets off and pushes her bike.

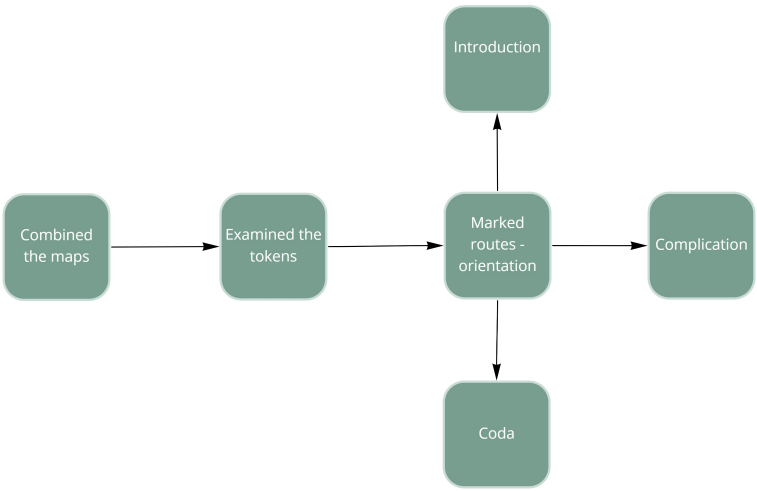


Figure .3.1: Participant Five has combined the maps and branched all other activities from the mega-map they have created.

Structure The participant was clear from the outset that she wished to put the maps together even before she looked at the areas .3.1.

She was the second participant to create a token representing *anxiety*.

She marked the routes she took and used colours, assigning each route a colour. She approached this like a schematic transport map, in that in the shared sections she would put both hues .3.2. The assignment of colours does not seem to follow the emotional response as red, which ordinarily tends to be associated with alarm and energy [236], was used for what the participant called a 'quiet route'.

The participant created two tokens, one on my instruction (*rule breaking*) and the one without a prompt (anxiety). Although she did talk about the *rule-breaking*, she never put it on the map. In contrast, the token for *anxiety* was inserted twice in the same location as the participant wanted to **reinforce** the message.

This participant has noted difficulty in capturing some aspects of their experience. "*I am not really sure how to represent that*" In some cases, the participant only

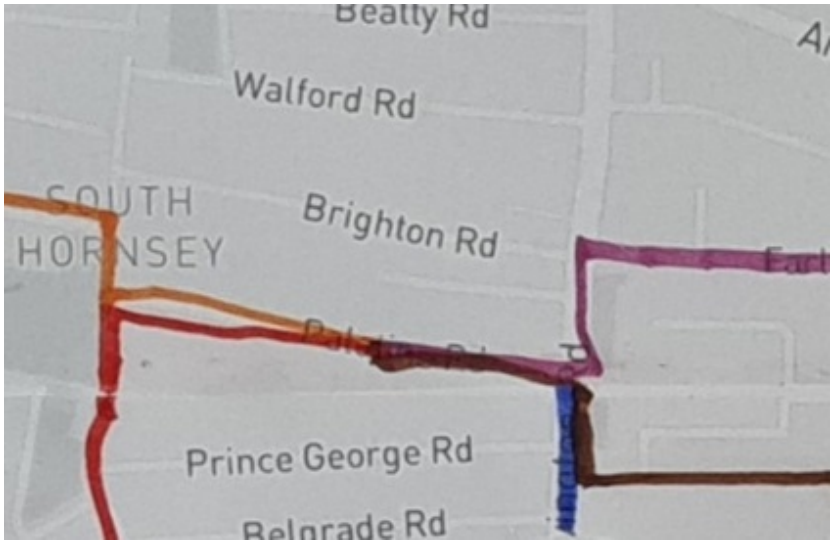


Figure .3.2: [P5- Study 2] Participant Five's use of colour to identify different routes at a junction point.

relied on verbal communication. This was despite having created some tokens previously; being experienced in creative expression; and having a range of materials at her disposal. Her solution was to augment the tokens with writing in order to **define scope** (at night).

She has used tokens to create a contrast between the preferred route and the alternative. She has grouped tokens with positive connotation (*safety, independence* on the proffered route, while clustering tokens for *cars and buses* on the adjacent road .3.3.

Another interesting behaviour that this participant exhibited was the use of one token (*potholes*) to represent another phenomenon; difficulty in crossing the road. To do that she has inverted the token so that the holes represent bumps.

Summary

"*I am getting into it now!*"

Cycling seems well-integrated into the life of this participant. Her life is spread among several locations that are too far for walking but not far enough to require a car (except one location) and cycling seems a thread that connects most of it. Her work network is a reminder that her commute is not always a linear single journey and that the dynamics of work can change even without a change of profession and within the same organization.

The participant favours quiet roads as she feels more confident there, but also, in the case of cycling with her child, it enables interaction and family bonding. Cycling down roads that are not busy means that she does not have to be on high alert and the environmental noise is lower, which creates better conditions for conversation.

However, the frequent act of cycling has developed her understanding of her ca-

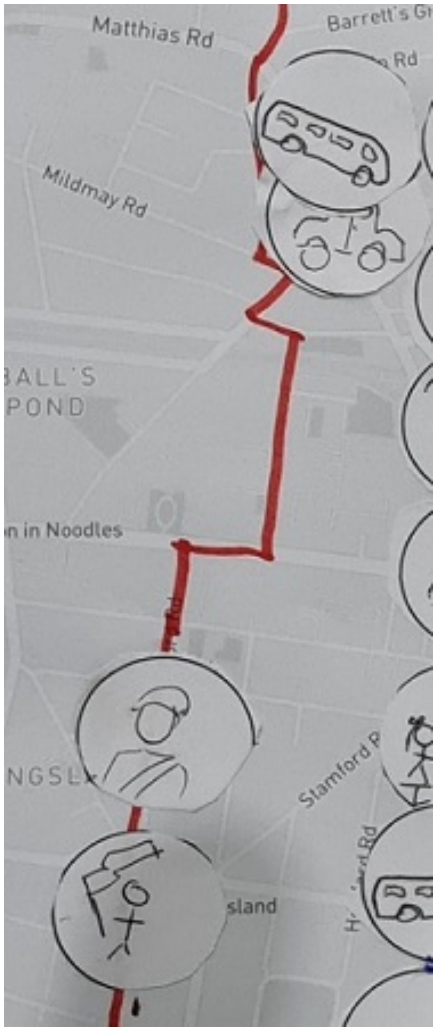


Figure .3.3: [P5- Study 2] Participant Five - The contrast of chosen route versus alternative illustrated with clusters.

pabilities as a cyclist and improved her understanding of cycling as an activity. She is increasingly taking busy roads and is less dissuaded from cycling due to environmental conditions.

"**I used to only cycle when the weather is good but the weather does not bother me anymore**" "*I used to avoid going that way, and I still don't like it, but I am much less nervous now.*"

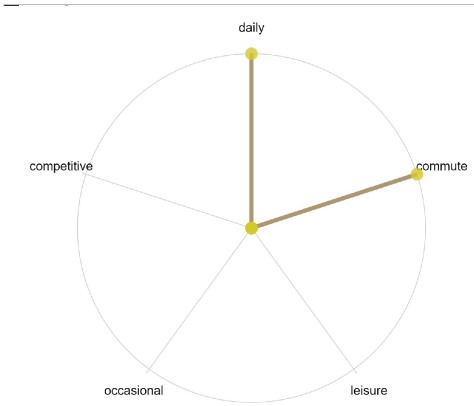
Propriety and rule obedience seem to hold importance for this participant as the inappropriate behaviour of other cyclists is more significant than that of the other thoughtless road users. The speculation is that as she is a cyclist, their behaviour reflects on her. This is an extension, and a different take on the same motivators that

are behind the 'safety in numbers' phenomenon [11]. While safety in numbers promotes security and anonymity by creating a sense of belonging to a mass, witnessing bad behaviour in other cyclists has a disturbing effect.

Further, like all the other people who took part in this project, she was asked to create a token for rule-breaking. During the session, she discussed the use of this token and the fact that she sometimes breaks the rules several times. She was always explicit that such behaviour is in order to keep herself safe and done very mindfully and with consideration for others. However, she has not actually used the *rule-breaking* token and put it on the maps. This is the only token that was discussed but not used.

She concluded by commenting that her participation in the session has led to several insights and realizations regarding her cycling and the cycling environment.

PARTICIPANT SIX - P6



P6 visual stamp



P6 example of output

Table .3.2: Visual stamp of self-identified cycling activity and an example of output participant has created.

- **Gender:** Male
- **Age :** 30-50
- **Profession :** Cycle mechanic
- **Ethnicity:** British
- **Importance of cycling for self-expression :** Very

Abstract: P6 works as a cycle mechanic and came across the study while working at Dr. Bike sessions. In the pre-session questionnaire, he described himself as someone who cycles daily and commutes. Dr Bike sessions are run at a variety of

locations (schools, universities, hospitals, public events) and in several London boroughs. However, he wanted to describe only one journey, which was not connected to his work as a mechanic but to his engagement with cycle training in schools.

Introduction "*So there is one journey that is challenging and should not be challenging.*" The route he decided to discuss is manageable dependent on being familiar with the area. The main issue he wanted to address was the *break in flow* and lack of cohesion between the constituent parts, which he described as pleasant.

Conflict

"*Potentially a really nice ride but it could be better*"

After describing which route he wished to discuss, and why, he described sections of the route in more detail. While some aspects were very positive, such as pleasant surroundings, in some cases this was marred by roads being used as a cut-through by *cars* and by being bordered by busy thoroughfares without appropriate crossing, which caused *break-in-flow*. Many quiet areas are hard to navigate due to *lack of signs*, causing *confusion*. Difficulty in navigation and the confusion caused by the lack of supporting street furniture are presenting a *barrier* for people new to the area or novice cyclists.

Resolution The last thing the participant did was suggest how the route could be improved. He pointed at the map as he talked (I could not see the map but I could see his arm) and picked out areas where there is a break in flow and how he would remedy this. The main solution was the addition of cycle furniture, in the form of signs.

Structure of Expression The participant chose a journey and the maps first, then started adding tokens. After describing the first two locations, he added the routes. He marked the preferable route and the alternative, using texture to distinguish them. He used coloured pens to classify, distinguish themes, and add verbal prompts. His use of the colour red was interesting, in that anything he circled in red applied to the whole map, not just the area he was circling The tokens were grouped and circled to signify that they all referred to a single location. He combined tokens to make causal statements. For example, putting a token for *alert* next to *bus* token to indicate an area where one needs to be vigilant due to traffic or *break-in-flow* next to *barrier* Fig. .3.4.

PARTICIPANT SEVEN - P7

- **Gender:** Female
- **Profession :** Teacher
- **Age :** 30-50
- **Ethnicity:** European
- **Importance of cycling for self-expression :** Not significant at all

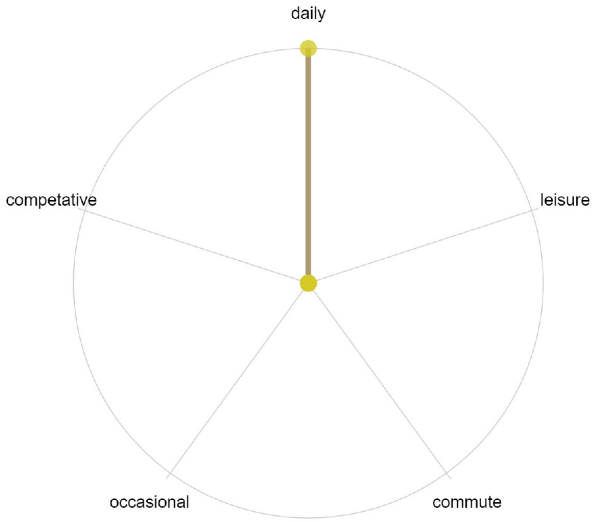


Figure .3.4: Participant Six combined tokens break-in-flow and barrier to create a causal instance. Break in flow, is a cause for people avoiding cycling here. He also used a green colour to signal that there are positive aspects to these localities.

Abstract This participant heard about the study through social media. Despite wanting to participate, she said that cycling is not significant for her self-expression. She performed the tasks very fast and in a very matter-of-fact way. For her, cycling is not problematic and she prefers shorter busier roads. The traffic, or safety, is not of concern.

Introduction She introduced her cycling by explaining that she has a limit on how far she cycles (13 km in one direction) as that is far enough and her bike is heavy. She elaborated that within that range she uses the bike for all her travel - the commute, utility and social outings. She often uses the pronoun 'we'.

Conflict (Maps 1 and 2)In the beginning, she examined the tokens and looked for a map that contained the themes she wanted to discuss. This was the map containing the canal towpath. She commented on the experience depending on the direction of cycling, such as the experience of inclines and the influence of the weather. Unusually, she flagged good weather up as problematic as it means that the towpath will be busy with people and problematic for cyclists. She continued to iterate through the tokens and put the ones that she found applied onto a map she chose. She chose the next map based on the destination and repeated the iteration process. As with the towpath, she discussed the clash between cyclists and pedestrians in shared spaces and expressed concern for the cyclists' safety. Here, she also com-





P7 visual stamp	P7 mapping

Table .3.3: On the left is the cycling frequency visual stamp, and on the right is an example of the output this participant has created.

ments on the temporal change in conditions as the park is less accessible on market days. Another consistent theme is the other cyclists.

"*Other cyclists? All, the time, all the time.*"// (Maps 3 -4) She chose to discuss the West End as it is very different from her experience of the local area and because she believes that not many people from Hackney cycle there. This area is much busier with traffic and she finds it more hostile. She described the infrastructure as incomplete, inconsistent, and riddled with potholes. There is a lack of cycling furniture and the area is in constant development, which can cause a sense of displacement.

"*There are lots mushrooming in the middle of the city, I was so shocked when I saw yesterday barriers everywhere because of the construction.*"

The continuation of the route she was exploring saw the deterioration of the supporting infrastructure, which led to confusion and the feeling of unease. While reflecting on the West End's lack of infrastructure, she addressed the presence of Santander Bikes (hire scheme) and the wisdom of providing the bikes but not the infrastructure. She also discussed the Santander bike hire users as a 'nightmare' on the roads.

"*Especially as a lot of the people who use these bikes, they are tourists. They have no clue. They don't know where to go. Some of them even cycle on the wrong side of the road.*"

"*This has been done by someone who has never been on a bicycle*"

Resolution After exploring the last (combined) map, she suggested a new route

to the West End that is nicer and more pleasant for cyclists. She also recapped the maps and talked about the positives of destinations; such as the opportunity to be with people and cultural content in the West End.

There should be a clear signing and an indication of how to go from A to B.

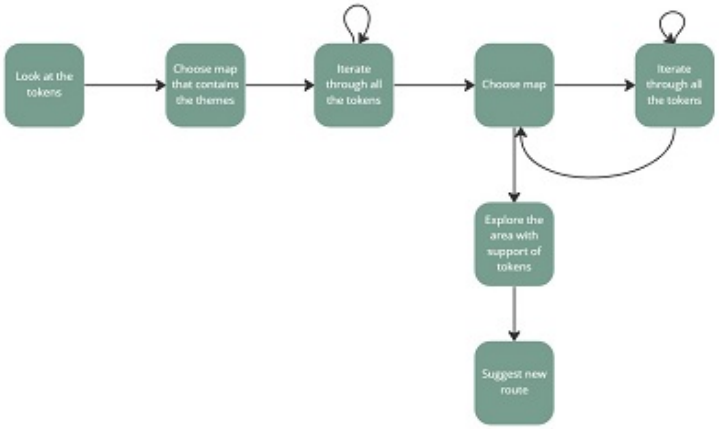
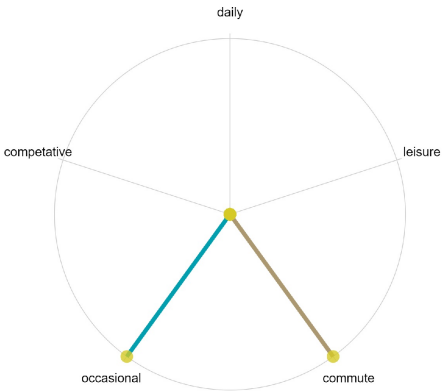


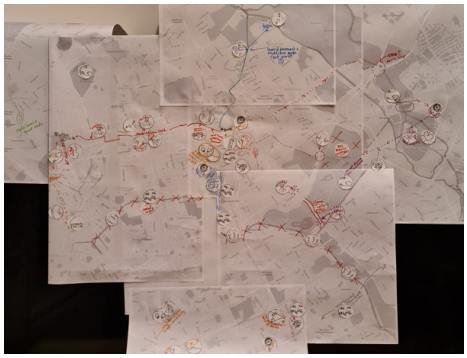
Figure .3.5: [P7- Study 2] Participant Seven started the exercise by quickly iterating through tokens without spending much time on the tokens themselves or the maps, this changed as the session progressed.

Visual expression She comments on the ambiguity of the tokens and their multiple meaning (people good and bad). She did not combine, or repeat tokens. She created one token, on my instruction, but did not venture to create, or modify any on her own initiative. She drew one route but only as she thought it was expected of her.



Figure .3.6: [P7- Study 2] Participant Seven combined two maps to explore cycling in the London West End area. She confined her expression to using tokens and only drew a route and one token as she interpreted a suggestion as instruction.





P8 visual stamp	P8 mapping

Table .3.4: On the left is the cycling frequency visual stamp, and on the right is an example of the output this participant has created.

- **Gender:** Female
- **Age :** 50 - 70
- **Profession :** Teacher
- **Ethnicity:** British
- **Importance of cycling for self-expression :** Very

Abstract This participant is a teacher and she uses her bike as her main form of transport. She commutes every morning, which she finds challenging, and has reflected on the temporal nature of the difficulties she faces. Mornings are busier and more stressful. She fully engaged with the materials and overran the allocated two hours for the session. She used all the materials at her disposal effectively, modifying 10 maps. She discussed the tension between the independence cycling gives and the vulnerability she feels on the roads. London is busier and the area is being gentrified which is bringing a change of rules, and spaces that used to be accessible are not so any more.

Introduction - Route 1 The first route she described is her route to work, which she finds challenging. She sets the stage by describing a perilous journey, where she feels everyone is trying to murder her. She expressed this strongly verbally and visually by using red, writing on the tokens and the map, and adding icons and effects Fig. .3.8

Complication - Coming back "**Coming home is another matter.**" She broadened the narrative by describing situations where she has to resort to rule-breaking as the combination of congestion and poor infrastructure leaves her no alternative.

"*...all the way around this road, on the pavement with guilt in my heart*"

She introduced another route and an issue of the cyclists-pedestrian clash, which she equated with gentrification as well as a lack of clarity as to what is cycle space and what is not. Talking about this, she was getting more agitated and as well spoke faster, she was punctuating her narrative by making numerous crosses along the routes she was discussing Fig. .3.7.



Figure .3.7: [P8- Study 2] Making of these crosses punctuated Participant Eight's narrative describing the difficulties she experiences while cycling along those paths.

"*And so it's just too congested, and they get annoyed and I get annoyed, all the cyclists are getting annoyed all the pedestrians are getting annoyed*"

She observed that she takes a circular route but looking at the map helped her decipher the reasons for taking it. Like participants one and two **??**, she used exploration in order to find an optimal route.

Looking at the tokens, she noticed infrastructure, which led her to discuss the Mini Holland provision, which she likes despite its drawbacks. She further continued to differentiate the ways that people who cycle use infrastructure and how they interact with other road users.

"*to be so frustrated because of the speedy cyclists, the lycra wearers, I would not use expensive infrastructure. So you've got old, old people like me, slow cyclists. Actually not only slow, more of a mixture, a mishmash of*"

She marked five routes on the combined map Fig **??** and augmented four individual maps. She identified junctions she finds dangerous, lack of parking, and clashes with pedestrians. She remarked several times that she must sound very angry but she was finding it therapeutic to discuss all the issues she encounters while cycling.

Resolution She concluded the interview with a general reflection on her cycling and some themes. For example, she remarked that some tokens elicited ambiguity as they have both positive and negative connotations. A token for *people* is an example, as in some instances she finds their presence comforting, while in others (towpath), they are a nuisance.

"*sometimes I like there being lots of people*"

She remarked that cycling gives her independence, flexibility, and control over



Figure .3.8: [P8- Study 2] Participant Eight uses all the materials that were provided in order to communicate the depth of her feelings.

her time and mobility. " *I might sound very angry but I have an equal amount of, you know when I have the wind in my hair I'm cycling along I'm very happy*"

While she opened the session with the route that she cycles for volunteering, and she has positive connotations about it, she never discussed it during the interview. Instead, she opened the narrative with an exploration of her morning commute, where she introduced the main issues, such as her feeling of vulnerability and anger. This was followed by an iterative process where she was at times led by a map, and at times by tokens. The main conflict was discussed while exploring the combined map and the resolution came with the inclusion of the additional areas .3.9.

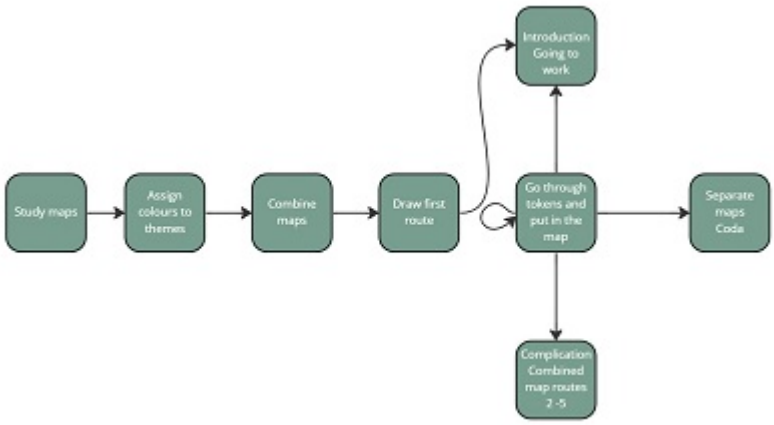


Figure .3.9: [P8- Study 2] Participant Eight was methodical and joined the maps, as well as familiarising herself with the tokens before commencing the task. The complication was discussed while exploring the combined map, while the resolution came after including additional areas. She took inspiration in turns, sometimes it was the map and sometimes the tokens.

Visual Expression This participant was organized and methodical. She com-

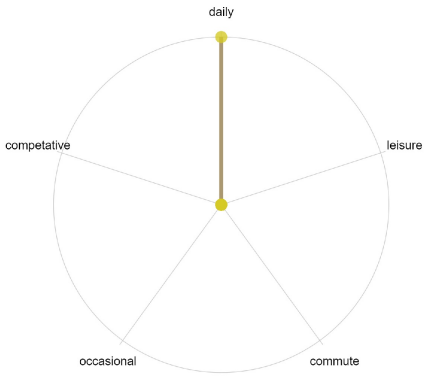
bined maps and assigned colours at the beginning. She wrote and drew on the map and on the tokens, but despite talking about themes that were not covered in the tokens, she did not sketch new ones but wrote on a couple of blank ones. A couple of tokens (*independence, pollution*) she stuck on the maps indiscriminately as they are not spatially bound. Although some areas might have higher pollution content, she did not make such a distinction. While working with the tokens, she drew happy or sad icons in order to classify them as positive or negative Fig. .3.10.



Figure .3.10: [P8- Study 2] Participant Eight used icons to classify tokens as positive or negative.

She immersed herself in the process and wanted to be very clear about what she is communicating. As well as classifying with icons, she wrote on the tokens, wrote on the maps, used texture (dots or crosses to distinguish routes), and used colour and emphasis Fig. .3.5.

PARTICIPANT NINE - P9





P9 visual stamp	P9 example of an output

Table .3.6: On the left is the cycling frequency visual stamp, and on the right is an example of the output this participant has created.

- **Gender:** Female

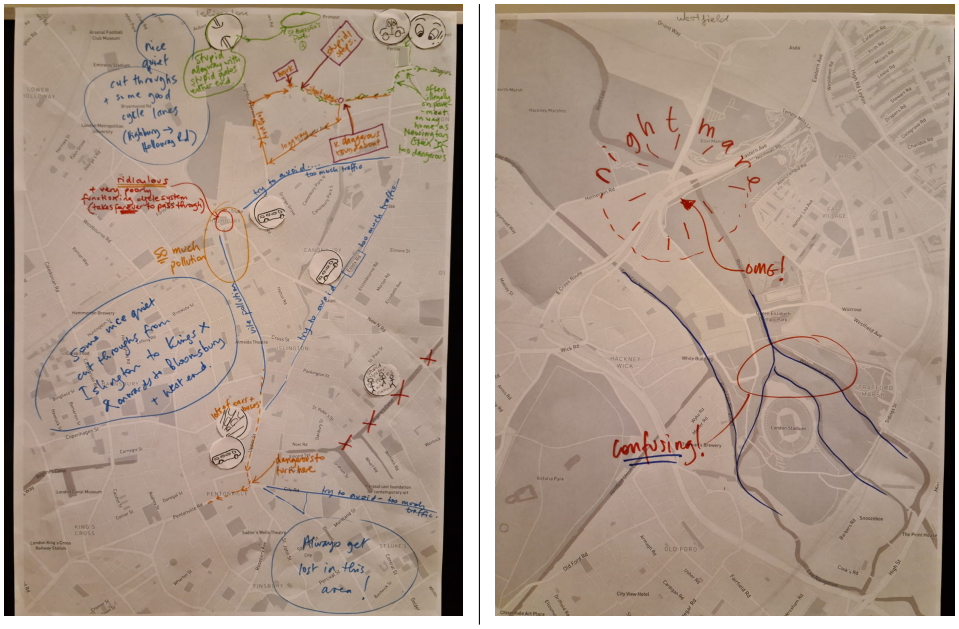


Table .3.5: [P8- Study 2] Participant Eight reinforced her narrative with the writing (left) and the visual emphasis devices such as circling the area with round writing and adding effects (right) .

- **Age :** 30-50
- **Profession : Teacher**
- **Ethnicity:** British
- **Importance of cycling for self-expression :** Very

Abstract This participant was born and grew up in London. She has cycled since her teens and knows the area well. She familiarised herself with the tokens and organized the maps. She was very prolific when it came to token placement and used a total of 158 tokens.

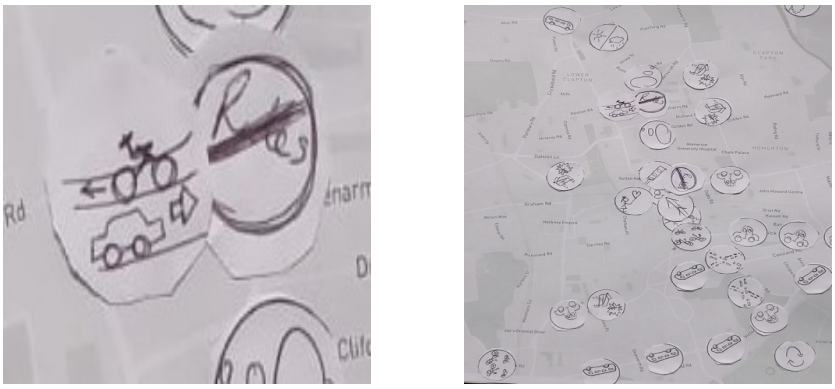
Introduction The first map she augmented is the area where she works and grew up. After a short reminiscence regarding learning to ride, she explained that for her, cycling is therapeutic and an opportunity for reflection.

Conflict - She remarked that she takes a different route home than she takes to work. She explored this with tokens and noticed that the route is polluted and busy, which made her question her habits. Continuing with tokens, she realized it was to avoid going uphill. She described in detail traffic light congestion and nuances of both the routes she uses for the commute. In the mornings she observes people and is contemplative. She is an all-weather cyclist but in extreme conditions, will use the car. She likes being surrounded by other cyclists as they make her feel safe and give her a sense of belonging.

Using another map she started talking about family cycling, which seems to be mostly in parks. She discussed the towpath and that she is finding it dangerous due to congestion. She also reminisced about her parents owning a canal boat for 30 years and how much she misses this.

"*So we had it for about 30 years. In my family. So very, very nice memory to have that*" Every map she used, came with an anecdote or a memory. "*So it's our first flat that we bought there, many a year ago..*" She also uses a bicycle for utility, like shopping.

Resolution After addressing the commute and the local area, she did, what can be described as 'map-hopping'. She went from map to map and related memories while sticking on tokens and chatting about memories she has of those places Fig. .3.13. The stories were bound together by a common thread, which is the bicycle journeys she did over the years and the places she goes to by bike. From the creepy museums to the day her husband first asked her out (she was on the bike).



(a) Tokens created by the participant

(b) The main map for the participant.

Figure .3.11: [P9- Study 2] On the first map, Participant Nine used a wider range of tokens (a) and created her own (b).

Visual Expression This participant liked working with the tokens and used them liberally. The first three maps had a range of themes and she also used rule-breaking, as well as creating her own token Fig. Fig .3.11. After developing and exploring the narrative that centred around her work commute and the local journeys, her use of tokens was perfunctory but still prolific as she was immersed in the memories and stories she was telling and putting the tokens on automatically Fig. .3.12. "*I'm just putting more buses on Victoria Park Road. Very busy road.*"

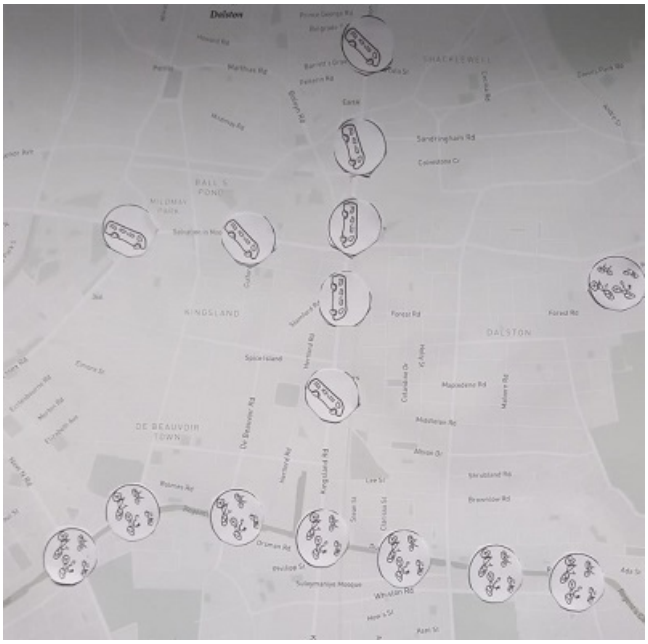


Figure .3.12: [P9- Study 2] Towards the end of the session, Participant Nine got immersed in the memories and the use of tokens became less diverse.

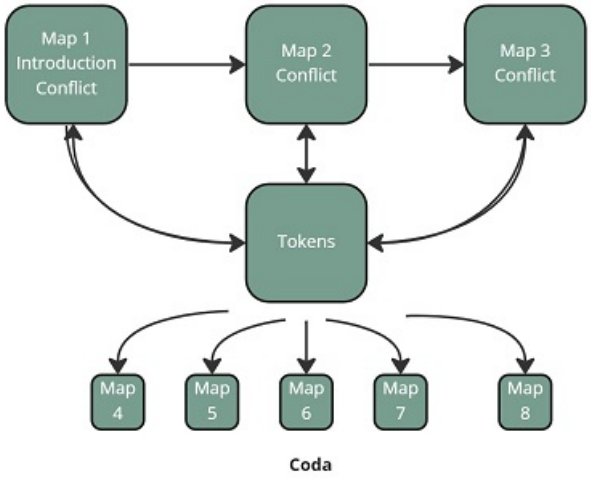
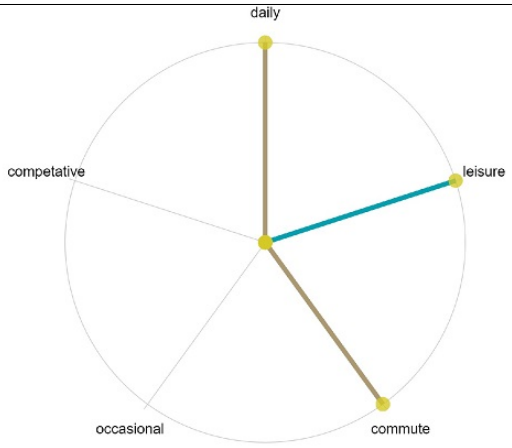


Figure .3.13: [P9- Study 2] In the introduction and conflict Participant Nine iterates between the maps and token how the story takes her. After completing the main story, she embarked on 'map-hopping' that elicits memories and moves away from the cycling narrative.

PARTICIPANT TEN - P10





P10 visual stamp | P10 example of output

Table .3.7: On the left is the cycling frequency visual stamp, and on the right is an example of the output this participant has created. It is mostly bare with only three tokens that have 'friends' and 'family' written on them.

- **Gender:** Female
- **Age :** 30-50
- **Profession :** Admin from home
- **Ethnicity:** British
- **Importance of cycling for self-expression :** Somewhat important

Abstract This participant has a family at the heart of her mobility and is the only participant who does most of their cycling with children.

Introduction For their first map, this participant chose the area around their home. They talked about a nearby park and *memory* they have associated with it, as well as new traffic calming measures near her home. While she advocated for them, she found the implementation chaotic and problematic. Cycling is the main mode of transport for her family and friends.

"*And you know they, they all cycled. So, parents and children are cycling together. We took a picture with 11 bikes and one children's seat*"

Conflict She looked at maps of the green areas and talked about the difference between family cycling during lockdown and outside lockdown. During the lockdowns they cycled for leisure, while outside it was more for utility, to get to things.

She expressed a preference for side roads and quiet roads when cycling and finds *gender -clash* she witnesses on the main roads quite upsetting. She remarked that

the behaviour seems worse in the mornings, which was the same observation P8 made.

"*Most of the man cyclists are really aggressive and really angry, more in the morning, than in the evenings. Hitting buses, hitting cars,*"

Also, other cyclists breaking rules is a problem when cycling with children as she is trying to teach them to be safe. She finds cyclists and other road users are not adapting their behaviour in a way that they should to make it safe, and normal, to cycle with children.

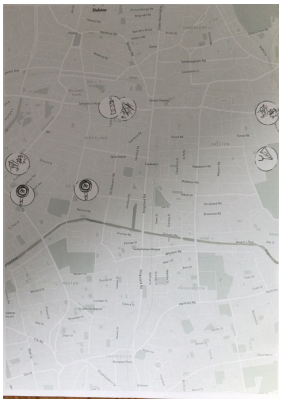
" *and I've been yelled at, with my children, by people wanting you to move, because we're taking up space, and I get very frustrated at that, but I don't say anything.* "

Resolution "*Just relax, we are all going to get there.*" After filling in three main maps and five supporting ones, the participant went through the tokens and added points to the majority of the maps. They recounted yearly family and friends outings and also talked more about the friction on the roads and their attitude towards it.

"*I like the infrastructure when it is there but I don't expect it. I accept that cars and buses are bigger than me, so I generally defer to them.*" She used *memory* token on three maps and this led to a comparison of cycling during the lockdown and what it was like after coming out. The lockdown cycling was leisurely and unencumbered by traffic. She found the change after the lockdown difficult as cycling on the road without cars and buses was less stressful.



(a) [P10- Study 2] Participant Ten introduction and complication

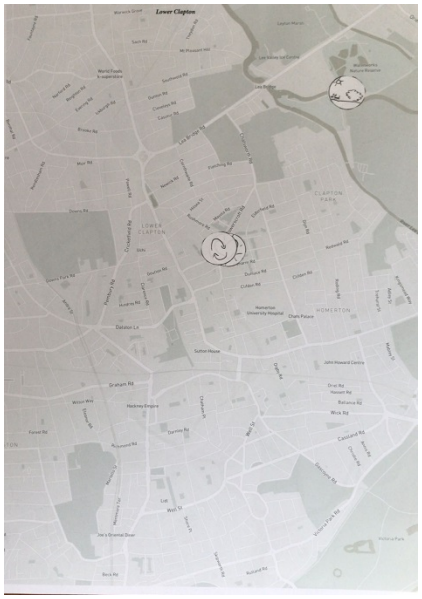


(b) [P10- Study 2 compilation] Participant Ten complication



(c) [P10- Study 2] Participant Ten complication.

Figure .3.14: Participant Ten main maps, which carry the narrative and contain more tokens than the supporting maps.



(a) [P10- Study 2] Participant Tenan example of a digression supporting map as created to illustrate a side story about secondary schools.



(b) [P10- Study 2] Participant Ten map supporting the narrative regarding cycling with children and outings..

Figure .3.15: [P10- Study 2] These are two examples of Participant Ten's supporting maps. For P10, the narrative was carried by the three main maps Fig .3.14 and she complemented it with supporting maps that would contain either a digression or would support a point mentioned in the main story. The supporting maps have fewer tokens.

Visual Expression P10 expression was map and memory led. She had three main maps and from there she bounced to other areas as memories came to her, and back again Fig. .3.16. She created two new tokens, which were written, not drawn. She did not modify any tokens despite my putting it to her as a possibility. She combined tokens regularly, sometimes even putting them on top of each other to indicate that they belonged together. Used *gender-clash* to both describe disagreements she had with her partners and issues they experienced with other male cyclists. Used *rule-breaking* to mark areas where she feels that she has no choice but break rules, but also combined it with *gender-clash* to illustrate her husband's different style of cycling with the children.

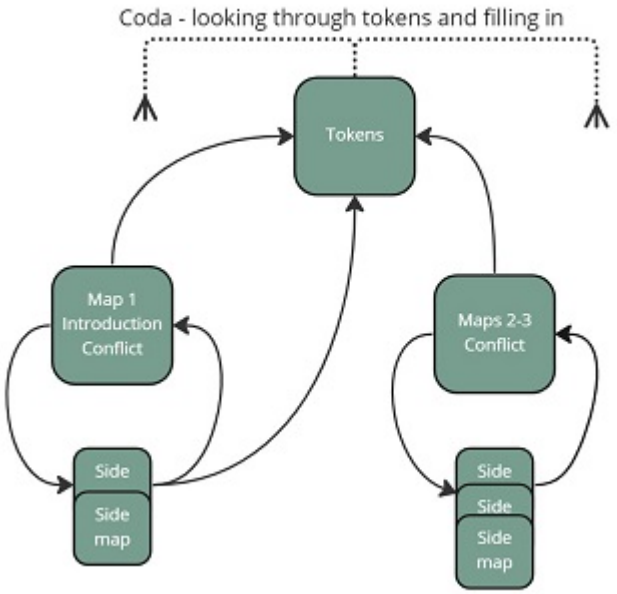
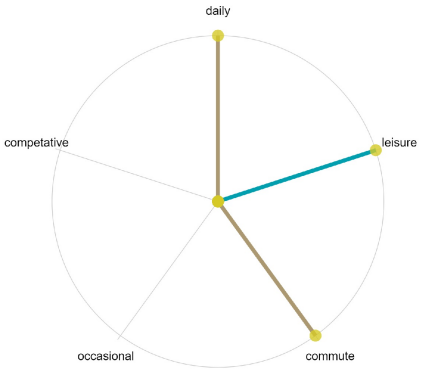


Figure .3.16: [P10- Study 2] Participant Tenwas initially led by the maps and their narrative. They created three main maps and five 'offshoots' that tied into the main narrative. The resolution and reflection came after they finished interacting with the tokens.

PARTICIPANT ELEVEN - P11





P11 visual persona	P11 mapping

Table .3.8: On the left is the cycling frequency visual stamp, and on the right is an example of the output this participant has created. It features the token she created 'home'.

- **Gender:** Female

- **Age :** 30-50
- **Profession :** Illustrator
- **Ethnicity:** European
- **Importance of cycling for self-expression :** Slightly significant

Abstract "*There's like certain areas of London that I've cycled through so much I have very strong sagging feelings about* "

Participant Eleven has cycled for more than 30 years, twenty of them in London. She found the tokens and the study very interesting as she had not thought about cycling in this way before. She examined the maps first and settled on areas she would explore. Her process was map-led and despite the instructions she tended to work quietly and not comment on what she was doing, or thinking. She said that the big themes of belonging, independence, joy, and flow were more at the front of her mind than the specifics such as lack of parking. The type of cycling she wanted to explore was 'fun destinations'. "*Places you choose to go to, rather than having to.*"

Introduction As an introduction, she explained that she wanted to talk about a historical journey, as currently she keeps very local. The first thing she addressed was *hills* as hilliness is something that she experiences keenly. She created a new token *flow* to represent the state of happy ease of movement. While the token *break-in-flow* has been used by most of the participants, she was the first one to identify the importance of the flow itself and thus express why the *break-in-flow* is important.

"*Is there one for flow? because it is a big one for me.*"

She also created a token that she called *home* and this represents the areas she is very familiar with. Following this, she worked quietly for 40 min resisting invitations to comment as she wanted to concentrate on the process she was going through.

"*It's like cycling in your mind.*"

Conflict "*So I've just realized that, actually, the things that I really marked were to do with stress levels.* " She divided the output (verbally) into the high-stress aspects (traffic, pollution, pedestrians, potholes) and the opposite (flow, home (belonging), nice surroundings, joy of movement, pleasant, liberty, and the feeling of independence). *Joy* and *independence* were together used on all the maps. Another issue she highlighted is junctions. "*I put alerts wherever there's a junction where you have to come out of your trance and deal with it.* " Her main themes were flow and belonging and she kept coming back to these themes.

Resolution She reflected on the independence and the fact that this is the first time she considered these themes consciously. " *I pretty much have a feeling of independence, because you realize, people usually take trains or public transport or cars to get to those bits, and I feel like on a bike, you can just go anywhere really quick, you don't, you're not restricted by much at all if anything, you're very free and don't... yeah it's a particular feeling* ."

Visual Expression The new token *flow* was used in combination with the token *thinking* Fig. .3.19. Despite being an artist and an illustrator, she opted to write the new tokens, not draw. She did not use any other materials besides tokens and maps. She was very prolific in marking (she has used 150 tokens) but not diverse. "*I realize*

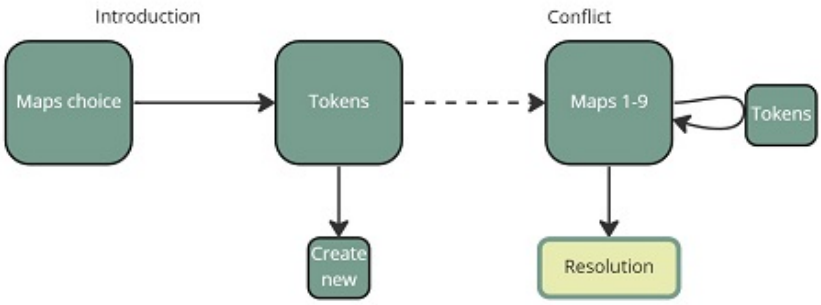


Figure .3.17: [P11- Study 2] Participant Eleven resisted a think-along, hence their narrative differs from others in that the resolution was not tied to a map. They introduced the narrative at the preparation stage and did not communicate during the exercise. .

that I have used the same tokens over and over again. Some of them I run out." The most popular tokens were *trees, car, joy, pedestrians independence and uphill.* She drew the tokens for *flow* and *belonging (home)* as well as adding two of *cars* as she had run out.

She did not apply the specific features but attempted to convey what is the essence of cycling for her.

After the interview, she added a token for *music* to the top of every map as it applies everywhere Fig. .3.18.



Figure .3.18: [P11- Study 2] Participant Eleven placed the token for music at the top of each map as it applies to all of the journeys and all the territories she visits.

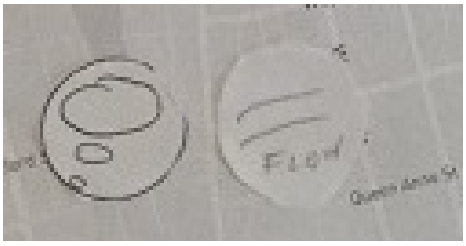
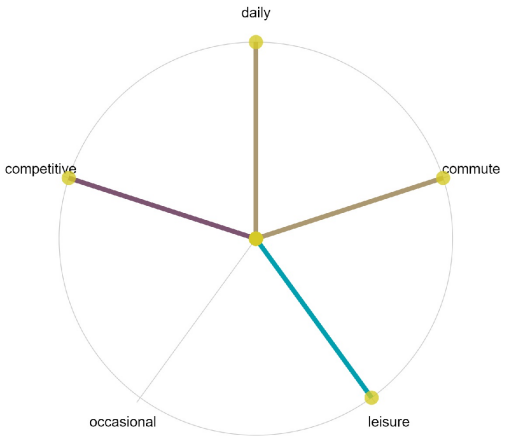


Figure .3.19: [P11- Study 2] Participant Eleven has created a token for the state of *flow* and combined it with the token for *thinking*.

PARTICIPANT TWELVE - P12





P12 visual persona	P12 mapping

Table .3.9: On the left is the cycling frequency visual stamp, and on the right is an example of the output this participant has created.

- **Gender:** Male
- **Age :** 50 - 70
- **Profession : Medical informatics specialist**
- **Ethnicity:** European
- **Importance of cycling for self-expression :** Very

Abstract Participant Twelve was one of three men that successfully completed the study. He uses the bike to commute, and for leisure, and is the only competitive cyclist in this study. Despite being one of the more active cyclists, he sees his experience as without depth and straightforward. However, he became animated when talking about cycling with his son.

Introduction He started his narrative by looking at the area around his home. He said that he was orienting himself and looking at where he was going. He marked his family, traffic and the local shops but then wanted to move along to explore other areas. Further into the study he returned to this map. He expressed that cycling, for him is only three experiences:

"*I only commute, cycle with my family and compete.*" He goes on to explain that commuting, for him is any type of utility cycling (shopping, hospital appointments...). However, he then added that he also cycles for fun and with his son and that every journey is different. In recent years he has started being very annoyed with the traffic and is cycling less to central London. He used to train in Regents Park as it is:

" *the only area in London where you can cycle relatively uninterrupted.*"

Conflict "*Cycling with the family, you are suddenly in prison. You can go 50 metres that way, 50 metres this way and you suddenly realize; this is a whole new universe.*"

Discussing cycling the quiet route with his young son, he expressed his own dislike of traffic and cycling on the main roads.

He continued to explain that LTNs and new infrastructure had opened up the possibilities for him to cycle with his son and that was his main focus now. He pointed out a few places that created infrastructure bridges and widened their cycling territory. He sees a problem in the lack of connections between the areas of good cycling conditions.

Resolution The main conflict of his narrative was the ability to cycle with his son and access London in his company. He highlighted the lack of connections and offered a solution.

"*Not every road needs to be perfect. You just need a gateway.*"

He also expressed a considerable dislike of cycling in traffic and on busy roads.

"*I do it for myself as well because I particularly dislike cycling on these big roads with heavy traffic. I am pretty confident because, as a teenager in Greece, I used to ride motorcycles, which is an extremely terrible and dangerous thing to do, so I don't lack confidence. But I find it extremely unpleasant to cycle in the busy streets.*"

Visual Expression Out of the seven maps this participant augmented, in six he marked the parks and the way one can access them. He did not modify the tokens but created his own ones, on which he wrote. The tokens he created were *family, race* and *fun*. He combined tokens *people* and *joy* to represent family, which he wrote next to the tokens.

He expressed difficulty in placing the abstract tokens as, to him, they are not spatially bound.

He attempted to classify areas by their purpose (fun, family, leisure, and training) and wrote these onto the maps.

.3.1 Flow of Engagement Diagrams

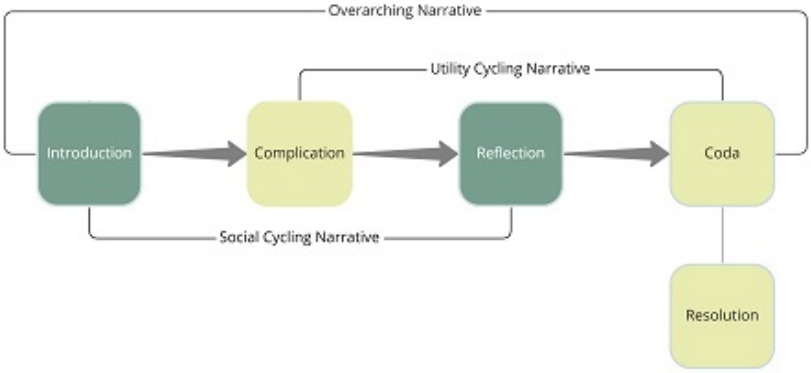


Figure .3.20: P1 flow of engagement diagram

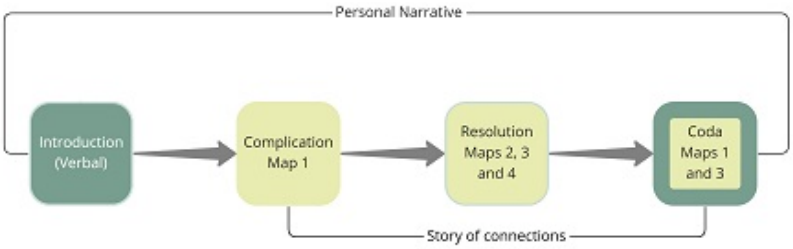


Figure .3.21: P2 flow of engagement diagram

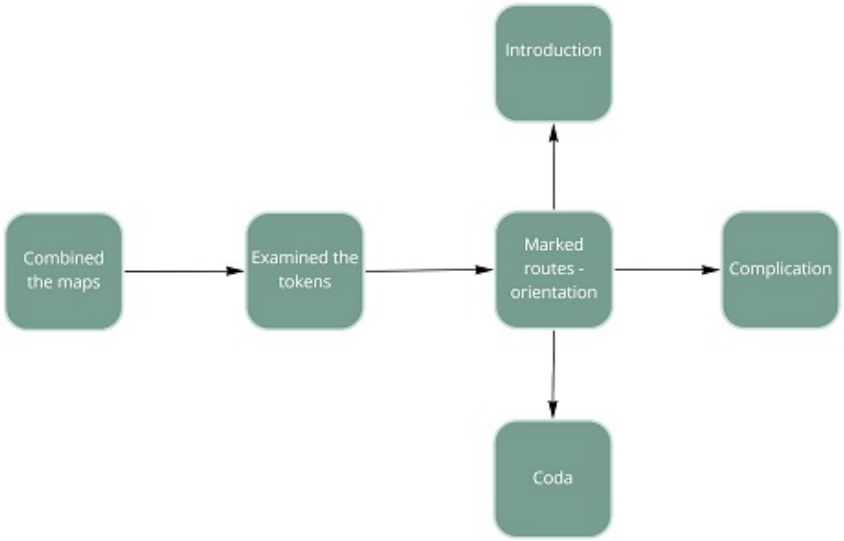


Figure .3.23: P4 flow of engagement diagram

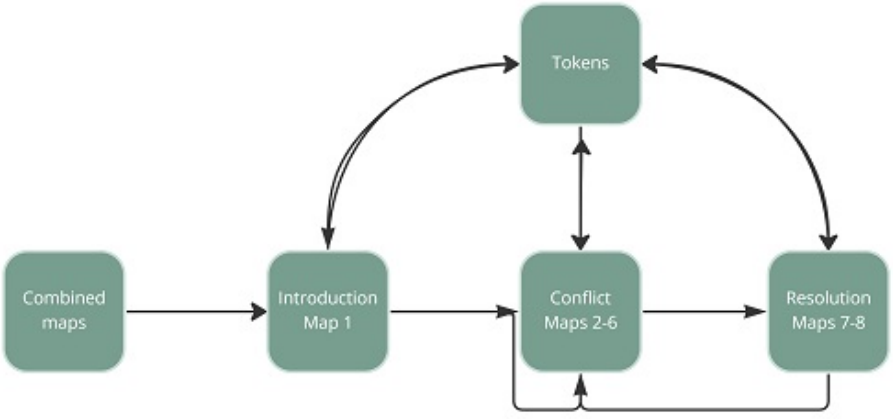


Figure .3.22: P3 flow of engagement diagram

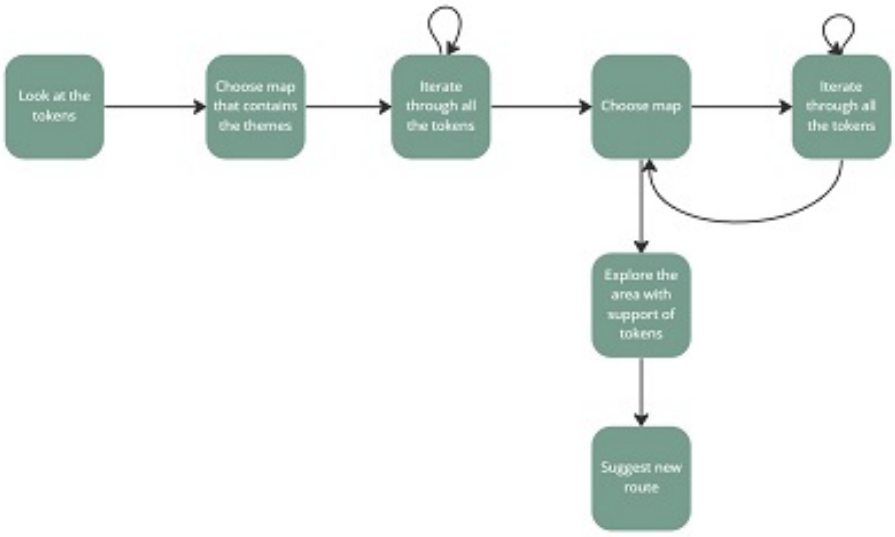


Figure .3.24: P5 flow of engagement diagram

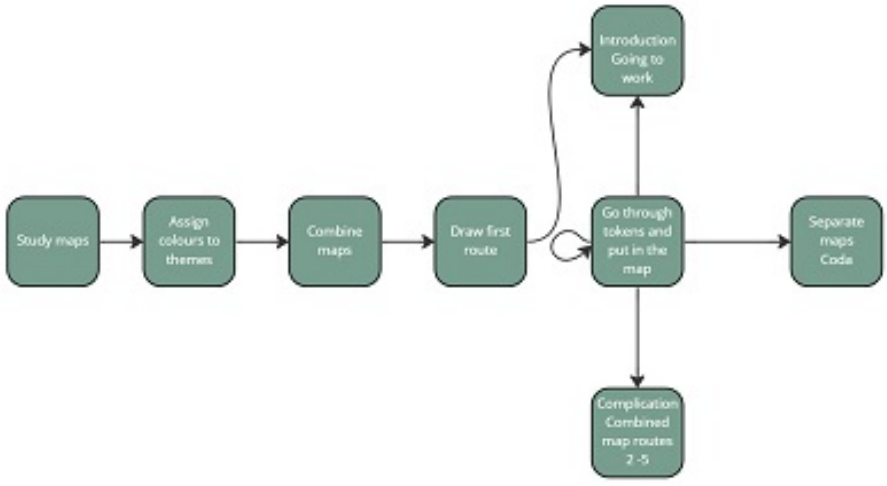


Figure .3.25: P6 flow of engagement diagram

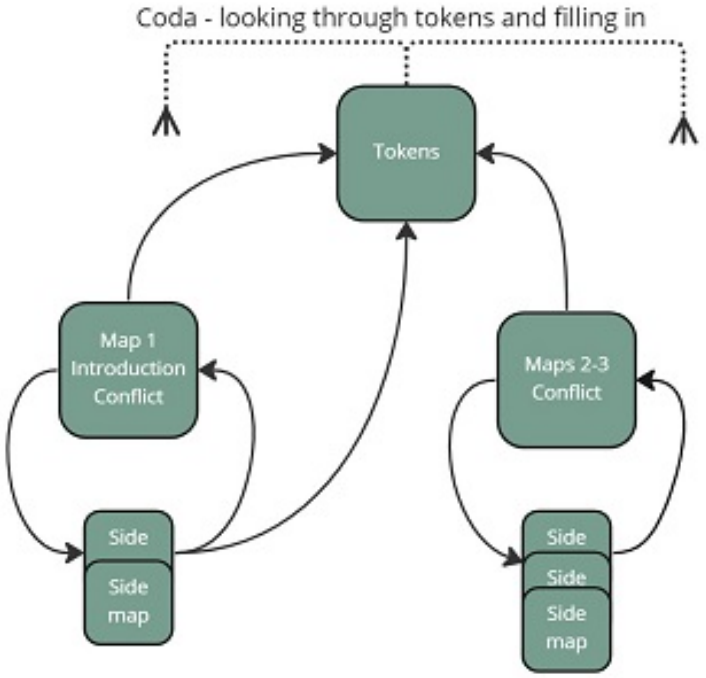


Figure .3.26: P7 flow of engagement diagram

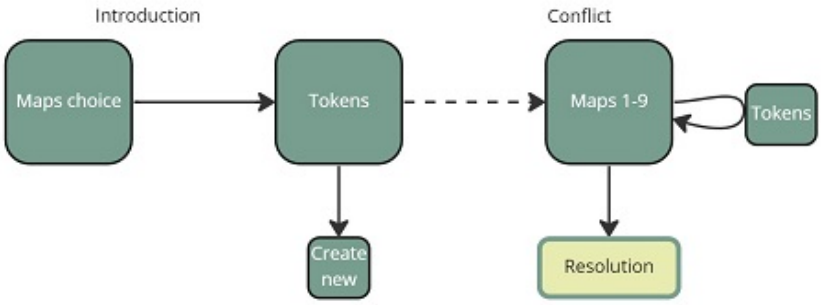


Figure .3.27: P8 flow of engagement diagram

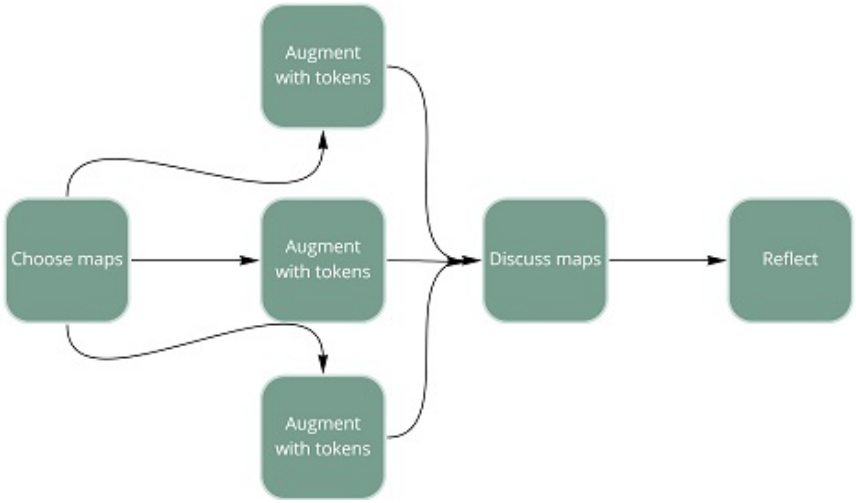


Figure .3.28: P9 flow of engagement diagram

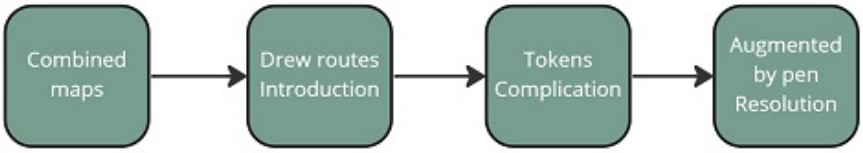


Figure .3.29: P10 flow of engagement diagram

.4 Study Three

.4.1 Ethics Approval Application

Role of GPS tracking based visualisation in capturing friction and flow in everyday life of cyclists

Risks

R1) Does this project have funding?
No

R2) Does the project involve human participants?
Yes

R3) Will the researcher be located outside the UK during the conduct of the research?
No

R4) Will any part of the project be carried out under auspices of an external the organisation, involve collaboration between institutions or involve data collection at an external organisation?
No

R5) Do your projects involve access to, or use of, material that could be classified as security sensitive?
No

R6) Does the project involve the use of live animals?
No

R7) Does the project involve the use of animal tissue?
No

R8) Does the project involve accessing obscene materials?
No

R9) Does the project involve access to confidential business data (e.g. commercially sensitive data, trade secrets, minutes of internationals meetings)?
No

R10) Does the project involve access to personal data (e.g. personnel or student records) not in the public domain?
No

Project Details

P1) Project title
Role of GPS tracking based visualisation in capturing friction and flow in everyday life of cyclists

P1.1) Short project title

Friction and Flow in Everyday in Cycling – Joy Riders study

P2) Lay summary of the background and aims of the research, including the research question (max 400 words):

This part of my research is devoted to the examination of cycling journeys made by the ethnic minority women, in particular women cyclists from Muslim and BAME backgrounds.

The **research questio**n I am posing is:

To which extent can some forms of automated data capture, translated into visualizations aid the process of extracting people's experiences**?**

Within this study I **aim** to:

- ***Capture and visually represent daily movement of participants in order to facilitate reflection and model daily cycling behaviour.***
- ***Provide mechanisms for evidencing micro-level journeys for the purpose of providing insights into how urban environment facilitates Muslim women cyclists and how they situate themselves, as well as function, within that environment.***
- ***Evidence processes an practices for mindful collaboration with underrepresented ethnic minorities.***

According to recent government figures (Travel in London Report 12, 2019), cycling in London is on the increase but in 2019, it still accounted for only 2.5% of all journeys made . If to this we add the fact that the men tend to cycle 2.5 more than women (Department for Transport, 2020), we can conclude that only 1% of all the journeys made in capital are made by women cyclists. Focusing on the general picture regarding the journeys women made, this disparity is even more surprising as a report by the Office of National Statistics (Ons.gov.uk, 2018) shows that women are more likely to work in jobs that are closer to their residence, hence a big portions of the journeys they make are under the 5 mile , which is a cyclable distance (Parliament.uk, 2017). The fairly recent, but growing of body of work, is explicitly examining the types of journey women make and what are the motivators, as well as mechanics of their transport choices and movement To add to the discussion, a new report from cycling advocacy group, Sustrans (Sustrans, 2020) highlights the lack of diversity in cycling that has its roots in lack of support, recognition and representation. While measures like improving overall cycling safety and access to instruction will go a long way to generally support cycling, I believe that lack of representation, on level of active transport promotion, research and development reinforces the gap in engagement and alienates minorities. Lack of engagement with minority groups is well documented in academic research (Sheikh, 2005; Emerald Insight, 2021).

P4) Provide a summary and a brief explanation of the research design, method, and data analysis.

The study has several elements and phases. The participants will be required to record their cycling activities over two weeks. Parallel to the recording, they will keep a 'simplified diary', which will take form of short daily survey. The survey will have a two-fold role. First as a prompt for the later discussion with the participant and secondly as one of the cornerstones for the analysis. At the conclusion of the two-week period, I will translate the captured movements into a digital visualisation and conduct an interview which will facilitate in-depth exploration and recollective analysis of the movement by the participant. (Braun and Clarke, 2013).

The participants will be recruited from the cohort of Muslim cycling group Joy Riders. The purposive recruitment process will aim to reach individuals who belong to the underrepresented cycling group. The recruitment will be conducted through a variety of channels, such as group's social media, word of mouth and in-person recruitment .

The volunteers will be sent the information outlining the purpose of the study, clear steps and expectations for the participation as well as information outlining the ways I will protect their privacy and safeguard the data. The volunteers that consent to take part will be sent a consent form, a hardware care contract and a list of possible dates for the induction.

The data collection will lasts two weeks and they will receive daily prompts with the 'simplified diary' link. The collected data will be processed and visualised and the visualisation used as a structure for a semi-structured interview. The participants will be expected to complete a post-task in the form of a follow-up questionnaire in order to capture the reflective value of the process. Data collected will consist of the results of the initial questionnaire, participant's diary entries, recorded journeys, visual translations of the journeys and the accompanied visual design, audio-recorded interview and answers to a post-task questionnaire.

As a mixed-method study, this project is aiming to integrate quantitative and qualitative aspects. In the Sequential Transformative method (Castro et al., 2010) neither qualitative nor quantitative approach takes precedence and the results are integrated. While initial data collection will be a concurrent process, thematic analysis of the qualitative data will inform the type and the extent of the quantitative analysis.

P5) What do you consider ethical issues associated with the conducting of this research and how do you purpose to address them?

The main ethical issue to consider is the preservation of the participant's anonymity, privacy and ensuring transparency regarding the handling and storage of the individual's movement data. In order to minimise the risks and ensure that there is no loss of confidentiality, the researcher will take the following steps:

- Data will be stored on the device provided by the university that is password protected and uses bit encryption. Only the researcher has the password and only the researcher will have access to raw data and the participants' information.
- All collected data will be anonymised prior to any publication of the results. All the identifiers will be modified in the following way.
- Participants will be given pseudonyms (Participant 1, Participant 2…).

- The interview content will be transcribed and only the transcriptions used in any academic discussion or collaboration. No one besides me will hear the voices of the participants.
- Age will be generalised by classifying the participants in the age-range groups.
- To avoid the possibility of participant's home being identified, I will implement a combination of strategies: In cases where multiple trips are shown, I will remove street-names from the maps that are on small scale and where the location cannot be discerned from the street layout; the data that is within 100 meters of the participant's residence will be removed; no map where the removal has created a noticeable gap will be used in any of the publications; the maps used for publication, and promoting this work, will be carefully curated to ensure the anonymity.
- The participants will receive full information as to the purpose of the study prior to deciding whether to accept the invitation to take part.
- The participant will be informed as to the extent and granularity of data to be collected.
- The participants will be informed that the researcher will collect only information that is relevant to the study.
- Participants will be informed which steps will be taken to anonymise data and de-identify movement visualisations (such as removing street names in the images used for publication).
- The participants will be informed that they are free to withdraw their participation, with no consequences, at any point before the submitting for publication.
- Participants will sign a consent form before taking part in the study.
- The participants will be informed that their personal information, such as name and contact details, will be known only to the researcher and kept only for the purpose of identifying the relevant materials in case they wish to withdraw from the study at the later stage.
- If a participant decides to withdraw their participation, before work is submitted for publication, all information that relates to them and all the insights that resulted from it will be removed and erased.
- The participants will be informed about how the data will be stored and who will have the access to it. All the digital materials, such as de-identified raw audio recordings, digital questioner and feedback forms will be deposited at the university approved data repository or stored securely on a data-encrypted password-protected computer. All the material artefacts, such as written notes that result from the sessions will be securely stored in a lockable cabinet at the university. Only the researcher and their supervisors will have access to the data.
- The interviews will be video-recorded and the participants will be reassured that any facial features will be obscured in stills that might be used in the work that results from the workshop.
- Participants will be asked for consent to use the anonymised stills from the workshop.
- There is a minimal risk that the reflection and discussion of the cycling experience will remind a participant of an unpleasant event. To mitigate that, the participants will be informed of this possibility in the information sheet. They will also be informed that both parties, the researcher and the participant, will be able to stop the session at any point should such recollection surface and cause distress.

P6) Project start date.

Upon receipt of the ethic's approval.

P7) Anticipated project end date.

The data collection will last for 9 weeks after the start of the project, while the analysis will be ongoing through the writing-up of the theses.

P8) Where will the research take place?

The induction meetings will take place at the public venue or during the group rides organised by Joy Riders. The interview will take place at the public place. Such as a coffee shop, or over Zoom if the COVID situation results in another lockdown.

P10) Is this application or any part of this research being submitted to another ethics committee, or has it been previously submitted to an ethics committee?

No

Human participants

The options for the following question are one or more of:
'Under 18'; 'Adults at risk'; 'Individuals aged 16 and over potentially without the capacity to consent'; 'Non on the above'.

H1) Will person from any of the following groups be participating in the project?

None of the above.

H2) How many participants will be recruited?

6

H3) Explain how the sample size has been determined.

The sample size for this study needs to satisfy criteria for qualitative analysis, which due to the depth and volume of information per participant dictates a smaller sample size (Braun and Clarke, 2013). The sample size is calculated in a way that incorporates both different cycling abilities and caring obligations. The abilities I wish to capture are: beginner cyclists, occasional cyclists and an advocate. Also, as mobility of care (Plyushteva & Schwanen, 2018) is seen as primarily female phenomenon, I wish to recruit a sample which consists of women that have explicit caring responsibilities, in the form of parenting. Parenting duties evolve with time and the sample should recognise this. This work is not seeking to extract truisms regarding the behaviour of ethnic minority cyclists but to examine role and function of micro-movement visualisation in supporting and stimulating expression, as well as s lay grounds for future work and analysis.

H4) What is the age group of participants?

The only stipulation regarding the age is that the participants cannot be younger than 18 as that is the legal age of adulthood. There is no upper limit.

H5) Please specify inclusion and exclusion criteria.

There are no age criteria for the study, as long as participants are of legal adult age (18 and over). While the first two studies look ed at cycling in broader terms, this study concerns female cyclists of minority ethnic origin (Muslim and other BAME women) and is aiming to recruit a stratified sample in regard to cycling experience, cycling habits and caring responsibilities. This is due to the previous findings that care for the dependants influences women's daily trajectories (Plyushteva & Schwanen, 2018)and how they function within their environment. All the participants will need to self-identify as people that cycle.

H6) What are the potential risks and burdens for research participants and how will you minimise them?

The participants might feel that they are exposing their daily lives to a greater detail they are used to and be concerned how such a personal snapshot will be used. I will inform them about all the measures that I am taking to ensure their anonymity and explain that the study is not examining what they do but how the environment is enabling them to do it and how our methods help them reflect on this.

They might also feel worried regarding about whether they are a true representative of their ethnic minority as there is not much academic research done in this area. There is a slight risk that the participant will choose to record only the journeys they feel should represent someone from their society. Even if some of the participants 'filter' out part of their activity, the journey they decide to keep will give us a snapshot of the participant's actions and relation to their urban surroundings. The participants will be asked what proportion of the journeys was captured.

As the participants will be recruited from diverse socio-economic backgrounds and with diverse interests, some of them might not feel confident with the technology. The researcher will provide documentation with instructions prior to the sessions and allow for technical difficulties in the time planning.

H9) Will you be recruiting pregnant women, women in labour, or the women who have had a recent stillbirth or miscarriage?

This is not intention of the study but there is a possibility that some individuals would fall in this category as we are not screening for it.

H8) Will you directly recruit any staff and/or students at City?

Not

H9) How are the participants to be identified, approached and recruited?

The experience of recruiting for the first two workshops have given me insight into difficulties and barriers of recruiting a diverse sample. As general advertising is often missed by ethnic minorities, I have identified cycling organisations that work with broadening gender and demographic diversity in cycling. In particular, Joy Riders and Cycle Sisters a Muslim female cyclists organisation. I have made myself known to the organisations and have established that they are willing to help recruitment upon the ethics approval for the project. The recruitment would be over their established channels, which are WhatsApp groups and the Facebook page. A message explaining the purpose of the work, logistics and the time demand will contain a link to the expression of interest survey made in Qualtrics.

The entirety of digital communication will be conducted via dedicated mobile device. This decision is partly based on the specialists knowledge of the Joy Riders and Cycle Sisters ride leaders regarding the usual manner of communication in their cohorts and partly on the recruitment off and communication with the participants for the second study, where third of the cyclists that expressed the initial interest could not take part due to the need for use of technology. A SIM card will be purchased that will be in use only for the duration of the project and which will be destroyed at the completion of the last communication with the participants.

H12) Describe the procedure that will be used when seeking and obtaining consent, including when consent will be obtained.

The consent will be obtained electronically as it will be hosted on Qualtrics. The individuals that have filled in the expression of interest form and fit the recruitment criteria will be sent the information sheet and the consent form . The participants will have a 24 hour period to consider the participant information before signing the consent. The consent will be obtained prior to the induction and any further engagement will dependent on the applicants reading and signing their agreement.

As successful participants will be in possession of City UoL hardware for the two weeks of data collection, they will be asked to signed a hardware use contract also. The participants will be given a PDF copy of both forms for their records. The paper copies will be handed over at the start of the induction session.

H13) Are there any pressures that may make it difficult for participants to refuse to take part in the project?

No.

Human participants: method

M5) If the research is intended to benefit the participants, third parties or the local community, please give details.

Research primary objective understanding of the extent visual stimuli helps reflective process and facilitates the collection of experiential data. A side-effect of the reflective process is a greater understanding of one's actions and the drivers behind these thus improved relevant experience..

M6)Are you offering any incentive for participating?

Yes. The participants will be offered a £25 M&S voucher. The amount has been based on the National Living Wage (£8.91/hour) and the average expected time a participant will spend doing the tasks and in the interview, which amounts to three hours. The voucher will be given upon the commencement of the involvement.

Times estimates:

Fill in survey (S) : 4 min/day

Turn the device on (D) : 5 min

Interview (I) : 90 min

Formula:

Hours of engagement (X) = ((Number of days * S) + (Number of trips * D) + I) / 60

We are estimating an average of 3 trips per week.

X = ((14 * 4) + (6 *5) + 90) / 60

= (56+ 30 + 90)

= 176 / 60

= 2.93

Data

D1) Indicate which of the following you will be using to collect your data.

GPS tracks of movement
Interviews
Video recording
Audio/digital recording interviewees or events
Surveys

D2) How will be privacy of the participants be protected?

Any public display or publications including the thesis will anonymise all individual data depictions including maps and interview transcripts and remove any data relating locations or other data that could be used to identify individuals, such as home location or its immediate surroundings. All the identifiers will be modified in the following ways:

- Data will be stored on the device provided by the university that is password protected and uses bit encryption. Only the researcher has the password and only the researcher will have access to raw data and the participants' information.
- Participants will be given pseudonyms (Participant 1, Participant 2…).
- The interview content will be transcribed and only the transcriptions used in any academic discussion or collaboration. No one besides me will hear the voices of the participants.
- Age will be generalised by classifying the participants in the age-range groups.

D3) Will the research involves the use of direct quotes?

Yes.

D5) Where/how do you intend to store your data?

Raw data will be stored on the device provided by the university that is password protected and uses bit encryption. Only the researcher has the password and only the researcher will have access to the participants' information and the the data prior to de-identification.

.

Material outcomes of the sessions, such as sketches and annotations, will be kept at the locked, home location till return to the university.

D6) Will personal data collected to be shared with other organisations?

No.

D7) Will the data be accessed by people other than the named researcher, supervisor or examiners?

Yes.

D7) Explain by whom and for what purposes.

The participant's personal information will be accessed only by the researcher and for the purpose of communication with the participants.
The outcomes of questionnaires, transcripts of the interviews, raw recordings, GPS routes will be analysed and the, findings, quotes and visualisations based on these will be used at the conferences and in publications in the manner that is explained in the information sheets and agreed to in the consent form. Furthermore, the data collected will comprise a unique and valuable dataset, which might be of use for future research topics and of distinct scientific value. The anonymised data will be published to support academic publications that result from the study and used in collaborative projects for the duration specified in this document.

Commented [RM1]: Data being made available for dissemination.

D8) Is the data intended or required (e.g. by funding body) to be published for reuse or to be shared as part of longitudinal research or different/wider research project now or in the future?
No

D10) How long do you intend to keep the research data generated by this study?
The data will be kept for five years . This period will cover the remainder of my PhD and allow for further developments of the project.

Commented [RM2]: Length the data kept and justification.

D11) How long will personal data be stored or accessed after the study has ended?
All data will be kept for five years.

D12) How are you intending to destroy the personal data after this period?
The data and electronic media will be destroyed following the process and requirements indicated by City, University of London.
The key to the participant's identity will be kept in a separate and password protected location.

All digital data will be de-identified and only referenced by a unique participant identifier. Destruction of electronic media will be logged via Service Now website.

Health & Safety

HS1) Are there any health and safety risks to the researchers over and above that of their normal working life?
No

HS3) Are there hazards associated with undertaking this project where a formal risk the assessment would be required?
No.

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.4.2 Participant Information Sheet

Study title: Friction and Affinity in Everyday Life of Cyclists
REC reference: Mirela Reljan-Delaney (Low risk)
Researcher: Mirela Reljan-Delaney, [redacted]
Supervisors: Prof Jo Wood, [redacted] Dr Alex Taylor, [redacted]

Dear potential participant,

I would like to invite you to take part in a ***movement tracking based individual workshop*** that is a part of the research I am undertaking as a part of my PhD at City, University of London.

Before you decide whether you would like to take part it is important that you understand why the research is being conducted and what it would involve for you. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more detail. You will be given a copy of this sheet to keep.

It is important to take note that for the purpose of this research you will be asked to ***record your cycling activity for two weeks using GPS enabled device*** that we will provide for this purpose and for the duration of two weeks. Also, at the begging and the end of each day, you should answer questions regarding your planned cycling characteristics. I will send you reminders regarding this. All the data collected and used in research will be anonymised and de-identified. However, it will be your data and only take part in this research if you feel comfortable providing it.

What is the purpose of the study?
My PhD is looking at the possibilities for ***capturing and expressing cycling experience using visualisation*** and the purpose of this study is to capture instances of micro-mobility and through visualisation and interaction collect a snapshot of individual cycling experiences of women cyclists from the minority ethnic background. In London, only 27% of cyclists are female and even smaller percentage Muslim. While efforts are being made to redress some of this unbalance, more can be done to understand the specific relationship minorities have with cycling and the urban landscape. This study is a part of a wider project that uses combination of quantitative and qualitative methods to access the knowledge and potential for better integration of urban landscape with its inhabitants that is locked within individual experience.

Why have I been invited?
You have been invited because you *are* ***a female, identify as ethnic minority cyclist, adult (age 18 or over).*** If you choose to participate, you will be one of 6 participants taking part in this study. The invitation is open to all individuals who express interest but it is constraint by the number of participants we are able to accept.

What should I do if I want to take part?
Read the participant information form (this document) and sign the consent form*. The* consent form has a sections for contact details and I will be in touch shortly. There are few questions relating to attitude to cycling attached to the end and we would appreciate it if

you could answer those, but they are not obligatory. You can always contact me if you have any questions.

Do I have to take part?

Participation is voluntary; it is up to you to decide whether or not to take part. ***You can withdraw at any stage prior to submission of the research for publication and without being penalised or disadvantaged in any way.*** If you do decide to take part, you will be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason. Just let me know, and we can end things very easily and immediately. An email stating that you wish to withdraw will suffice. In a case that you withdraw, I will dispose of any materials relating to your participation and exclude anything that we have discussed from my conclusion. If you wish to halt the video-workshop and withdraw, you can say so at any time and the same procedure regarding the documentation, materials and findings will be applied. However, the data is collected in order to be used in a published research and my ability to disregard your input stops at that point. We hope that participation will be fun and enriching experience.

What you will be asked to do?

Your involvement will be in three parts. The initial survey and the consent form will be sent to you electronically. Once you are in possession of the device, you will be expected to switch in on and take it with you for ANY trips you do using bicycle. The device can be kept in a pocket and does not need any attention from you until the end of the outing/cycling journey. At the begging and the end of each day, you should answer questions regarding your planned cycling characteristics. I will send you reminders regarding this. The device will be with you for two weeks and the recording will be at your discretion. After two weeks, I will collect the device and we will agree a mutually suitable date for one-to-one session during which you will have a chance to discuss and reflect on your experiences. We have made every effort to minimise time commitment and make this a positive experience for all the participants.

What are the possible disadvantages and risks of taking part?

This study is not designed to elicit discomfort or to provoke in any form but if for any reason you feel discomfort, we will discontinue the session in order to avoid any further distress.

There are no other foreseeable risks, harms or possible side effects associated with participating in this study. Nothing you do or express will be under any scrutiny. The research is about understanding the decision drivers and capabilities of the expression space, not about judging what you do in any way.

What are the possible benefits of taking part?

While there are **no *specific benefits in taking part,*** we hope you enjoy the experience of participating in the research.

Also, taking part in the exercise might result in a more reflective outlook regarding your cycling habits and this might lead to more immersive experience.

Furthermore, the research aims to further understanding of the cyclist's experience and deepen understanding of the methods for eliciting relevant knowledge. This will be of benefit to the wider cycling community and cyclists in general.

Expenses

We do not expect that you will incur any expenses as all the materials will be provided. We are grateful to you for your time and commitment to furthering of knowledge and as a token of that appreciation, the participants will be given £25 M&S voucher.

Will my taking part in the study be kept confidential?

The data collected that is results from the study will be kept by the university for possible re-use in the development of subsequent projects and will be retained until it is no longer of any development value. Your name will NOT be included at any time and you will be de-identified in the artefacts, audio recordings and any transcripts made of. In the event that any of the visual outputs, such as visualisations of trajectories, are to be used in publications, any distinguishing features , will be modified or omitted. Any direct quotes used will be anonymous and will not contain any personal or identifiable information. Prior to anonimisation of the data, only the research team (comprising of me and my supervisors) will have an access to it.

Any public display or publications including the thesis will anonymise all individual data depictions including maps and interview transcripts and remove any data relating that could be used to identify individuals, such as home location or its immediate surroundings. Your personal information and contact details will be known only to me and will be kept at a secure location. In particular, on a device provided by the university that has bit-encryption and password protection. I will need to keep this information in order to identify your input in case you express a wish to withdraw from the study.

What will happen if I do not want to carry on with the study?

You are free to withdraw from the study at any time without giving a reason and without being penalised or disadvantaged. However, following submission of the resulting research for publication, I will not be able to eliminate your contribution from my conclusions or from any resources that are being published in support of these.

Data privacy statement

City, University of London is the sponsor and the data controller of this study based in the United Kingdom. This means that we are responsible for looking after your information and using it properly. The legal basis under which your data will be processed is City's public task.

Your rights to access, change or move your information are limited, as we need to manage your information in a specific way in order for the research to be reliable and accurate. To safeguard your rights, we will use the minimum personal-identifiable information possible (for further information please see https://ico.org.uk/for-organisations/guide-to-data-protection/guide-to-the-general-data-protection-regulation-gdpr/lawful-basis-for-processing/public-task/).

City will use your name and contact details to contact you about the research study as necessary. The only people at City who will have access to your identifiable information will be Mirela Reljan-Delaney. City will keep identifiable information about you from this study for 5 years after the study has finished.

You can find out more about how City handles data by visiting www.city.ac.uk/city-information/legal. If you are concerned about how we have processed your personal data, you can contact the Information Commissioner's Office (IOC) https://ico.org.uk/.

What will happen to the result of the research study?
The results of the study form a substantial part of my PhD thesis, will potentially be published in scientific journals, be a part of conference proceedings and might be used for teaching purposes and included in presentations to a wider public

Who has reviewed the study?
This study has been approved by City, University of London Computer Science Research Ethics Committee (CSREC).

What if there is a problem?
If you have any problems, concerns or questions about this study, you should ask to speak to a member of the research team. If you are dissatisfied with the response, you can raise a complaint through City's complaint procedure.
To complain about the study, you need to phone 020 7040 3040 or email dataprotection@city.ac.uk and speak with the Secretary to Senate Research Ethics Committee and inform them that the name of the project is citing the study's name and stating your case.

You can also write to the Secretary of the Senate Research Ethics Committee at:

Anna Ramberg
Research Integrity Manager
[redacted]

If you are unsatisfied with the City's response, you may contact Information Commissioner's Office at ww.ico.org.uk.

Insurance
City holds insurance policies which apply to this study. If you feel you have been harmed or injured by taking part in this study you might be eligible to claim compensation. If you are harmed due to someone else's negligence, then you might have grounds for legal action.

Further information and contact details
Researcher: Mirela Reljan-Delaney, [redacted]
Supervisors: Prof Jo Wood, [redacted], Dr Alex Taylor, [redacted]

Thank you for taking the time to read this information sheet.

.4.3 Project Plan

Study title: Friction and Affinity in Everyday Life of Cyclists - **Study Three**
REC reference: : Mirela Reljan-Delaney (Low risk)
Researcher: Mirela Reljan-Delaney, [redacted]
Supervisors: Prof Jo Wood, [redacted], Dr Alex Taylor, [redacted]

Project Plan

This is a breakdown of the third workshop for the project ' Qualitative Visualisation: Friction and Affinity in Everyday Life of Cyclists' which examines the role of maps and visualisation in unlocking of the cycling experience and the cyclists' relationship with their environment. This workshop partly builds on the findings of the first and second study but it dives deeper into an individual narrative. The workshop aims to reveal habits, motivators, barriers and patterns of daily journeys. The participants will be asked to use a passive GPS tracking device and record their journeys, which will then form the basis for the visualisation design and individual workshop session. The recording stage will be over a two-week period and the individual workshop a week after that. The participants will have a control over which journeys to record and at which point to start recoding them.

This project plan is organised in several sections:

- Set-up and general information
- Route collection
- Individual workshop

Friction and Affinity in Everyday Life of Cyclists Workshop	
Set-up and general information	
Delivery mode	Workshop/interview with user tracking.
Location	Combination of remote online communication and meetings in public places. The location will be decided depending on the situation concerning COVID-19 restrictions that will be in place at the time of the meetings. As the COVID-19 situation is dynamic it is unwise to propose an inflexible course of action.
Type of interaction	One-to-one
Type of workshop	A design-based interview –the participants will be asked to interact with an web-based visual design based on their activities during two weeks. They will have ability to examine renderings of individual journeys as well as overall activity. The representations will have temporal, spatial and behavioural aspects and will be supported by daily survey data. The combination of visual representations and

	contextual prompts are designed to evoke their actions as well as the meanings behind them. .
Type of interview	Semi-structured. The participants will be asked questions based on the outputs collected, as well as a set of questions that were asked in the first study. This will provide continuity and enable consistent analysis.
Communication with the participants	All the communication prior to the workshop, except for dropping off and collection of the GPS devices, will be digital. The participants will contact the researcher via text message or email.
Materials for participants	• GPS tracker supplied by the researcher. • A phone.
Materials for the researcher	• A PC or a laptop. • A device with microphone and camera. • Zoom account. • Copies of information sheet. • Copies of the consent form. • Notepad and pen for taking notes. • Reliable internet connection. • A dedicated phone and SIM card.
Route collection	
Previous workshops in this project-series have relied on participant memory as a reference. In order to contextualise cyclists, situate subjective impressions in the actual landscape, as well as identify unconscious patterns and nuances of micro-mobility, the participants will be asked to record their journeys during two weeks The participants will be given GPS enabled cycling computers which will collect the data passively. The GPS route collection will be supported by a 'simplified diary'. This is a minute-long survey that I will be sending to them twice daily and in which they will record their plans and realisations of those plans. The information will be used to support the design process and as a prompt during the sessions. The participants will self-manage the recording process and choose what they wish to share but will be asked what percentage of the cycling have they recorded.	
Type of activity	Independent, individual activity with remote communication.
Materials for the participant	• Cycling computer with GPS tracking • Instruction leaflet for the use of the device. • The instructional video for the use of the device.

	• A device capable of sending and receiving email messages for communicating with the researcher.
Materials for the researcher	• A laptop or a PC. • Copies of the information sheet. • Copies of the consent form. • A dedicated phone with a SIM card.

The Workshop		
Time	Activity	Materials
Leading up to the workshop		
2 hours prior	Email/text participants with the reminder and confirm the appointment. In case that is raining on the day, re-schedule.	Phone.
1/2 hour prior	Check that the equipment is working and that the planned location is available.	Recording equipment.
During the workshop		
0:00 15 min	**Introduction** **Aim** • Aim of the introduction is to share information regarding the content of the workshop and the logistics. • To make sure that the participant has understood the content of the Participant Information Sheet and answer any questions they have. • To make sure participants understand their rights, implications of taking part in the study and how data/materials will be handled. • To establish rapport and put the participant at ease. **The Activities** • Welcome the participant. • Make sure they settle in before commencing recording. • Make sure they know that they will be able to have a break at any time they need to. • Share a copy of information sheet. Ask if they have any questions and make sure they are aware of their rights. • Inform them of the session structure. • Check that they are aware that the session will be recorded.	Printed copy of the participant Information Printed copy of the consent form

	• Ask them to inform you if they need a break at any time.	
0:15 5 min	**Familiarisation activity** The participants will be shown the maps containing visualisations of their data and be invited to test different functionalities and ask questions. **Aim** • For participants to familiarise themselves with the visualisations and orient themselves. • To evaluate their first expressions . • To collect data regarding the initial accessibility of visualisation and the immediacy of engagement. **The Activities - Researcher** • Make sure the participant is comfortable. • Record the participants first impressions by making notes and audio recording. • Make sure the participant understands what is presented to them. That the key is understood and correctly interpreted. • Answer the participant's questions. **The Activities – Participant** • To familiarise themselves with the material that is given to them. • To aske questions.	• Custom maps • Audio recording device • Note-taking materials
0:20 40min	**The interactive interview activity** The participants are engaged into a conversation regarding the content of the interactive maps. While the interviews are individual and the direction will be determined by mapped behaviours, as well as participant's interpretation, structure will be provided by the same method of the data collection, as well as treatment of the data. **Aim** • To provoke participants into considering their cycling environment and decisions that they are making in the context of that environment. • To elicit response and reflection regarding their individual experience of cycling. • To record the process of interaction with the personal, physical representations of their action. • To get in-depth qualitative information • To help evaluate participant's experience of the process.	• An electronic device for viewing maps and interacting with them. • An online meeting platform such as Zoom or Microsoft Teams.

	• To produce materials for analysis. **The Activities - Researcher** • Initiate and curate the discussion. • Assure the participants that there is no right or wrong answer. • Ask: What do you see? What is missing? What should be there? What did you do then? How did you feel? Was this easy? Was it hard? What does it mean to you? Does this make it clearer? • Assure participants that they can take time. **The Activities – Participant** • To engage with the maps and interact with the representations. • To use map representations, and supporting visualisations, provided for exploration and expression of their cycling. • To narrate their thought-process and reactions.	
1:00 10 min	**Structured Interview** • The participants will be asked a set of questions regarding experience as a whole and regarding their attitude to cycling.	• A recording device. • A list of questions.
1:10 10 min	**End of the Session** **Aim** Provide closure and gather impressions. Complete admin tasks. **The Activities** • Thank the participant. • Remind them of the feedback form and suggest making a note of any thoughts that might occur them in the incubation stage (period after session). • Remind them that they can contact you at any time if they have any concerns.	

.4.4 Quoltrics Surveys Links

Qualtrics surveys for the third study

1. Expression of interest
2. Consent form and demographics
3. Hardware consent
4. Before ride questions
5. After ride

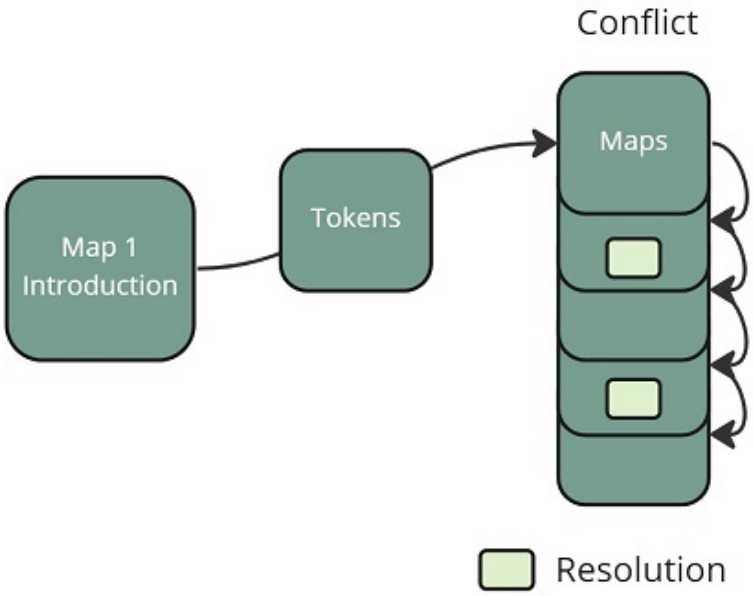


Figure .3.30: P11 flow of engagement diagram