



cycle BOOM

Design for Lifelong Health and Wellbeing

Summary of Key Findings and Recommendations

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DESIGN FOR LIFELONG
HEALTH & WELLBEING

FOREWORD

cycle BOOM was funded by the Engineering and Physical Sciences Research Council (EPSRC) under the UK Research Councils' Lifelong Health and Wellbeing Programme (Grant Number EP/K037242/1). The project was led by Dr Tim Jones at Oxford Brookes University and ran for three-years from October 2013 to September 2016. The end of the project was marked by final conferences in London (26 September) and Manchester (28 September). This report provides a summary of the key findings of the study with selected examples of evidence and also recommendations for promoting cycling as part of an age friendly cities agenda.

A series of Briefing Notes, videos documenting the cycle BOOM study and other outputs are available at www.cycleboom.org

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Background: Ageing, Cycling Mobility and Wellbeing

'Cities are, for the most part, spaces that are imagined and structured with a younger, working age demographic in mind. Older people are not, typically, incorporated into the mainstream of thinking and planning around urban environments.' *Handler, S. (2014; p12) An Alternative Age Friendly Handbook*

THE POPULATION ACROSS MOST of Europe is ageing as people are living longer and the birth rate is falling. Policy makers are looking at systematic approaches to support and encourage people to stay active for longer in an effort to reduce end of life morbidity and the wider impact on national health and care services. Conceptions of ageing are also changing and are now thought of, not only in a biological or medical sense, but also more holistically to emphasize autonomy, participation and wellbeing (Bryant, 2001). Notions of what constitutes the older population vary between different societies but the life course is often divided chronologically with older age starting at 50 or 65. While recognising the uniqueness of individual experience and the great heterogeneity among those in older age, a distinction is also sometimes made between the younger old (65-84) and the oldest old, those 85 and over who are 'more likely to experience frailty, illness and dependence in comparison with young old people' (Tomassini 2005). Mobility and independence are important constituents of wellbeing in later life as they allow older people to engage in meaningful activities outside their home and to gain a sense of control over the places they visit which in turn can help foster social engagement and a sense of belonging in the world.

Walking and cycling ('active mobility') have a significant role to play in promoting moderate physical activity as part of daily travel routines, delaying biological ageing and age-related conditions and improving overall health and wellbeing (WHO, 2002; Saelens et al., 2003). Cycling in the UK is less common than walking among the older population arguably because the built environment and associated technology is shaped around notions of youth, efficiency and economic productivity (Steinbach et al., 2011; Horton and Jones, 2015; Handler, 2014). As people age they adapt to changing physical circumstances (Rowles, 1978) and this allows some people to continue to cycle. But fear of injury and concerns about safety mean that the majority of the older population does not contemplate cycling (LifeCycle, 2010; ELTIS, undated; WHO, 2002).

Conceptualisations of 'older mobility' still remain narrow and cycling is simply not considered as something older people are capable of doing or want to do. This has resulted in a lack of vision and discourse on the potential for older cycling and subsequent guidance on the ways that the environment and technology could be adapted to support older people's cycling needs. But what if the potential for cycling among the older population was realised? What if UK towns,

cities and rural areas were shaped and designed to be more supportive of older adults cycling? What if cycling technology was more adapted to suit older people's needs? Under different circumstances cycling could play a more significant role in the lives of the older population (**Figure 1**). It could provide an additional mobility option for getting outdoors, moving around, connecting with people and engaging in activities. It could act as a valuable substitute for driving, public transport or walking, for example, when these become unavailable or more difficult because of a health condition. The burgeoning market of electrically assisted bicycles ('e-bikes') could also provide opportunities for the older population to prolong or re-engage with cycling and to stay active (AENEAS, 2011; Johnson & Rose, 2015; Jones et al., 2016).

This summary report provides recommendations on ways in which cycling can be developed as part of an age friendly cities agenda. This is underpinned by extensive empirical research that provides an in-depth understanding of the current and potential role of cycling in the lives of older adults in the UK.

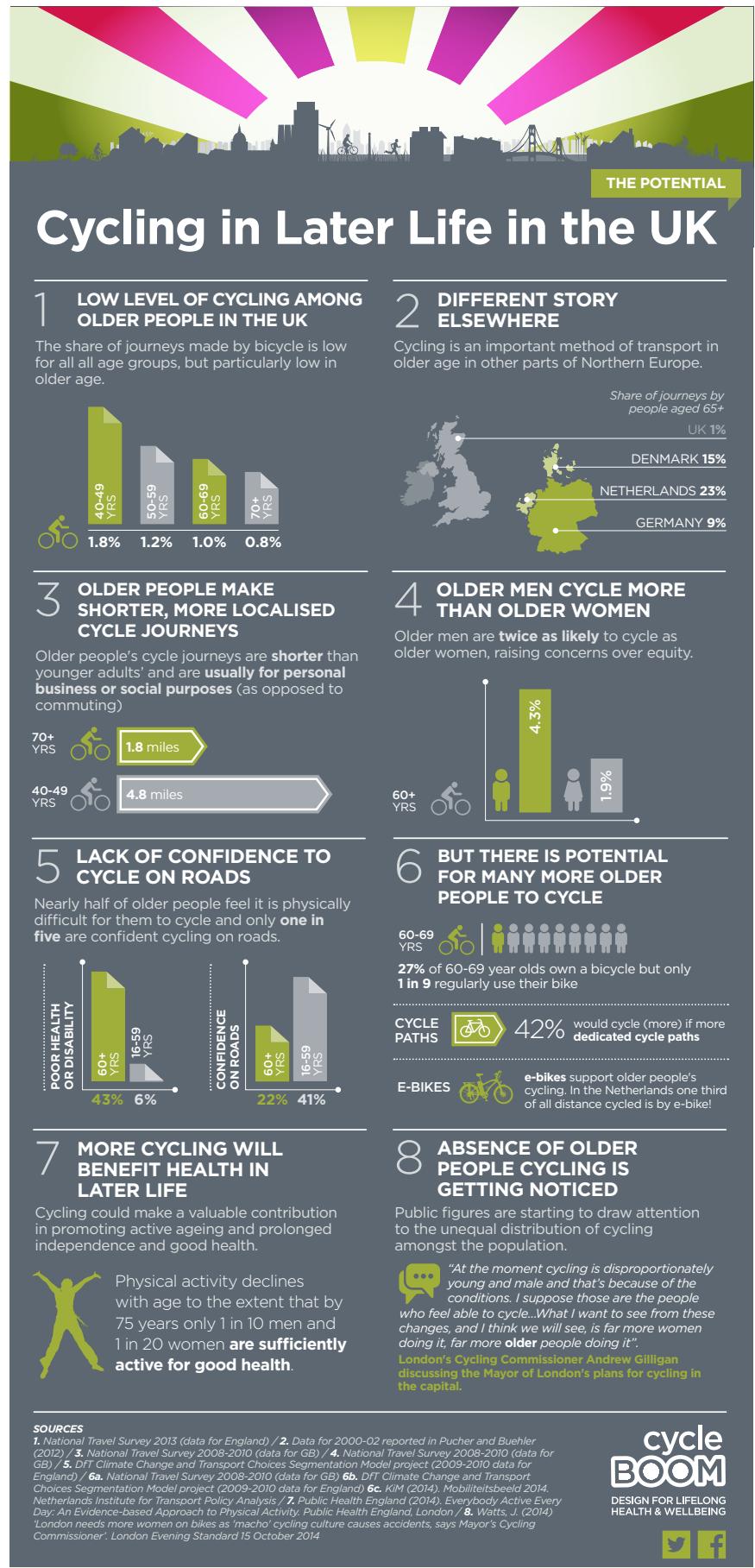


Figure 1. Portrait of 'problem and potential' for older cycling in UK

Ageing and Cycling: Policies and Trends

THE FIRST UK NATIONAL CYCLING STRATEGY

STRATEGY was launched two decades ago when cycling was recognized for the contribution it can make to improving public health and supporting environmental sustainability. Successive governments have built on this strategy and developed and implemented cycling policies with varying degrees of success. But government support for cycling in the UK has been inconsistent in comparison with the sustained support over the past half century in other northern European countries such as the Netherlands, Denmark and Germany (Pucher and Buehler, 2008). Furthermore, the scope for promoting older cycling has received little attention (Street and Black, 2016).

Levels of cycling in the UK among the older (and younger) population remain stubbornly low compared to neighbouring northern European countries. Cycling accounts for only 1 per cent of all journeys made by people aged 65 and older in the UK compared to 23 per cent in the Netherlands, 15 per cent in Denmark and 9 per cent in Germany (Pucher & Buehler, 2012). Furthermore, there is a sharp decline in cycling among the English population by the age of 50 (**Figure 2**). This is contrary to the situation in Germany, Denmark and the Netherlands where this decline is much less pronounced (Pucher and Buehler, 2008). The low rate of cycling in England is also set against a backdrop of declining public health among adults aged between 65 and 74 with around half of this age group failing to meet physical activity guidelines (HSCIC, 2014). Low distances cycled by those under 20 (**Figure 2**) point to younger people also being a group meriting attention.

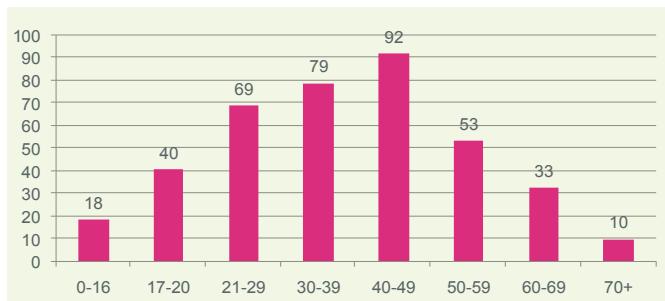


Figure 2. Average distance travelled by bicycle (miles) by different age groups in England in 2013 (Source: Department for Transport)

The potential for a greater number of older people to cycle is demonstrated by noting that over a quarter of British 60-69 year olds own a bicycle (27%) and 17% report having ridden a bicycle during the last year (**Figure 3**). The data shows that while bicycles are only used for about 1 in 100 trips for those aged 50 and above, a reasonably high proportion of this age group has some engagement with cycling.

Gender, class and ethnicity are more likely to shape levels of engagement with cycling in the UK compared to those countries in Europe with higher rates of cycling (Steinbach et al. 2012; Horton and Jones, 2015). Older people who own a bicycle and report using them are more likely to be wealthier white males. There is also a difference in likelihood in cycling based on where older people live with around three times the rate of cycling among those living in rural areas compared to those living in metropolitan areas (**Table 1**).

Data on attitudes to cycling highlight that a high proportion of people age 60 and above lack confidence to cycle on roads and feel that it is unsafe to do so. This coupled with higher

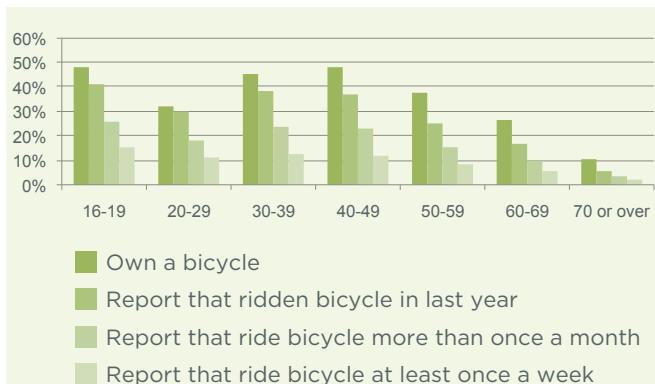


Figure 3. Bicycle ownership and use in GB 2008-10 (Source: Department for Transport, 2016)

likelihood of disability or health condition means that a high proportion of the older population would rather use public transport than cycle (**Table 2**) - concessionary bus fares may also be a significant incentive to use public transport over other modes including cycling.

In summary, it seems that those aged 60 or more are less physically able and are less confident to cycle. However, it is unclear what enables those that continue to cycle to do so, and for those that stop, it is unclear when and why this happens, and whether they could be encouraged to resume cycling.

Characteristic	Own bike (%)	Report bike trip (%)
Across all aged 60-69	27	3.0
Non-white White	7 28	1.6 3.1
Female Male	20 34	1.9 4.3
Highest Lowest income quintile	41 22	3.6 3.7
Live in purpose-built flat detached home	12 37	2.9 3.5
Live in metro area rural area	16 38	1.0 3.5
Own no cars 2 cars	14 36	3.5 2.9

Table 1. Characteristics of older cyclists (60-69 years of age) in Great Britain in 2008-10 (Source: Department for Transport, 2016)

Agree with statement	Age 16-59 (%)	Age 60+ (%)
Disability/health making it difficult to cycle	6	43
Not kind of person who rides bicycle	30	48
Confident cycling on roads	41	22
Too dangerous for me to cycle on roads	57	72
Cycle (more) if more dedicated cycle paths	55	42
Rather cycle than use public transport	40	18
I (would) enjoy cycling as a leisure activity	72	45

Table 2. Attitudes to cycling among different age groups in England 2009-10 (Source: Department for Transport, 2011)

Aim and Scope of the cycle BOOM Study

THE AIM OF THE CYCLE BOOM study was to develop a better understanding of how the design of the built environment and technology shapes engagement with, and experience of cycling as people get older, and how this affects their independent mobility, health and wellbeing. And following this; to provide advice to policy makers and practitioners on how the built environment and technology could be better designed to support and promote cycling among current and future older generations in order to improve independent living, health and wellbeing.

The investigation considered the built environment and technological 'system' at different scales from the micro-level (e.g. bicycles, equipment and cycle paths), the meso-level (e.g. housing, street design/layout and cycle routes) to the macro-level (e.g. land use patterns and information/service provision). It also considered the influence of early life experience in shaping later life outcomes and therefore the wider social/cultural, organizational, environmental, economic and technological changes over time.

Approach and Methods

A novel intensive mixed-method approach using both quantitative and qualitative methods was used to investigate how the design of the built environment and technology is shaping cycling mobility among an ageing population and the impact on older people's wellbeing. This involved (a) biographical interviews to understand how ability and willingness to cycle is shaped by life course experiences and events (b) mobile observation and video elicitation interviews to capture everyday experience of and engagement with cycling in the built environment and (c) a cycling and wellbeing

Four specific questions were used to drive the research:

1. How is ability and willingness to cycle shaped by individual life events such as family and social relationships, employment and wider social, economic and technological change?
2. How do specific features of the built environment and assistive technology affect cycling experience among older people and what is the impact on wellbeing?
3. To what extent does cycling improve older people's cognitive function, eudaimonic wellbeing (human flourishing), hedonic wellbeing (life satisfaction) and physical health?
4. What are the implications for cycling stakeholders, policy makers and practitioners?

trial experiment with new or returning cycle users to understand and measure how engagement in cycling in the built environment affects wellbeing. Biographical interviews and mobile interviews were employed at four case study areas in the UK: Oxford, Reading, Bristol and Cardiff (**Table 3**). Participants conducted the cycling and wellbeing trial in Oxford and Reading where a fleet of twenty electric-bikes or 'e-bikes' was available for loan. Each area varies in demography, scale and topography and in terms of the types of infrastructural support for, and levels of, cycling.

A variety of approaches were taken to recruit study participants with a range of cycling experience. As well as placing adverts in local print and digital media we developed a 'suite'

	OXFORD	READING	BRISTOL	CARDIFF
POPULATION				
All usual residents	151,906	155,698	428,234	346,090
Area (ha)	4,560	4,040	10,961	14,038
Density (People per ha)	33.3	38.5	39.1	24.7
AGE				
50-59	8.7%	9.7%	10.2%	10.9%
60-69	6.9%	7.2%	8.2%	8.3%
70+	7.9%	8.3%	9.5%	9.6%
All age 50+	23.5%	25.3%	27.9%	28.8%
TRAVEL AND CARS				
Journeys to work by cycle	17.6%	4.2%	7.7%	3.7%
Households without car or van	33.5%	28.3%	28.6%	29.0%
Vehicle density (cars & vans per ha)	11.3	16.5	17.4	10.9
STRATEGY FOR CYCLING				
	http://bit.ly/2cKzcSW	http://bit.ly/2cciiZ0	http://bit.ly/2cAVhB1	http://bit.ly/2cOaM9o

Table 3. Case study sites (Source: based on 2011 Census data available from UK Office for National Statistics www.ons.gov.uk)

of material targeted at potential participants. This included a prepaid ‘enquiry’ postcard which was disseminated at key locations across the four case sites, for example, libraries and community centres, cycle retailers and also clubs and organisations frequented by the older population. Cycling events (e.g. National Bike Week) were also targeted. A designated project administrator was responsible for managing all enquiries, supplying participant information (**Figure 4**) and organising research appointments. A site-based researcher focused research activities at each case site to develop in-depth knowledge of the local geography and culture and to reduce travel time and cost. All aspects of the study followed *British Society of Gerontology Guidelines on Ethical Research with Human Participants* (BSG, 2012).

A total of 554 applicants from across the four case sites completed a screening questionnaire and either returned a paper version by freepost or completed an online version on the cycle BOOM website. Every effort was made to select a pool of participants from a range of socio-economic backgrounds living in inner urban, outer urban, peripheral urban and outlying market towns and villages at the four case sites and who exhibited different levels of cycling experience and engagement with cycling. Participants were categorised as ‘approaching later life’ (50-59yrs), ‘in later life’ (60-69yrs) and ‘in old age’ (70+) and recruited in two separate waves (2014 & 2015). This allowed a focused period of data analysis after the first wave of data collection and an opportunity to make any necessary adjustments for the second wave in order to achieve a balanced group of

AIM AND SCOPE OF THE CYCLE BOOM STUDY



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This information sheet tells you more about the cycle BOOM study, and how you can apply to take part.

If you are interested in taking part complete the attached Application to Participate form and return it in the FREEPOST envelope within seven days (or complete it online at www.cycleboom.org.uk). You will receive a reply from the research team within 2 weeks after receiving it to confirm whether or not you have been selected and provide details of what to do next. Please get in touch using the contact details on the back cover if you have any questions.

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Design for Lifelong Health and Wellbeing

What is the purpose of the cycle BOOM study?

cycle BOOM is a study to understand cycling among the older population in the UK and how this supports health, health and wellbeing. The aim is to advise policy makers and practitioners how our environment can be designed to help people to continue to cycle in older age or to reconnect with cycling. This will be done through 'hands-on' studies, alongside a supported by a short documentary film.

Who is overseeing the study?

cycle BOOM is being led by Dr Tim Jones, a Senior Research Fellow in the Department of Planning at Oxford Brookes University, in association with the University of Reading, the University of the West of England (Bristol) and Cardiff University. Each University will carry out research in their local area, co-ordinated by Oxford Brookes.

1 of 4 | INFORMATION SHEET

What will happen to me if I take part?

The cycle BOOM study involves two different elements:

ELEMENT A - Cycling life history interview
All the selected participants will take part in an initial cycling life history interview.

ELEMENT B - Cycle ride observation and interview.
Those who already cycle will take part in a cycle ride observation and interview.

Those who no longer cycle and don't intend to cycle again will not need to do anything further.

Stages of participation:

```

graph TD
    A[Stopped cycling] --> B[Restarting cycling]
    B --> C[Already cycling]
    C --> D[A: Cycling life history interview]
    C --> E[B: Cycle ride observation and interview]
    D --> F[No further participation]
    E --> G[No further participation]
  
```

ELEMENT A - Cycling life history interview
Purpose: to understand the roles that cycling has (or has not) played in your life. This will involve completing a simple 'Life History Grid' to establish whether you have lived in different environments, places of work, education and leisure; methods of transport; hobbies/leisure activities; and when you last cycled in years. The task is straightforward and will take approximately one hour. We then contact you to organise a follow-up interview. You can decide whether this interview will be held at your local university or another convenient location. At this interview we will use the Life History Grid to explore the role that cycling has (or has not) played in your life. We will also look at some maps and street view images of the places you have lived to understand the types of environment for cycling. We will ask your permission to audio record the interview to help with our analysis.

Cycling life history interview
(Photo: Raleigh 2014)

ELEMENT B - Cycle ride observation and interview
Purpose: to investigate and document your experience of cycling in different environments. If you already cycle we will arrange a convenient time to observe you taking part in a cycle journey or activity. This will involve a researcher following you as you cycle. We will ask you to wear head gear fitted with a camera that can record audio wave signals. You will also be asked to wear glasses to record where you are looking during the ride. The lenses of spectacles if you wear them, are safe, fit comfortably and are hygienic. Sensors that record proximity to traffic, sound, ambient light and vibration during the ride will also be placed on your cycle. The researcher following you will ask you to stop at intervals to record your ride, and a video camera will also be attached to your pedal drive.

The researcher's role is not to interfere with the ride but to document your experience as if you were going about your normal business.

If I am selected what are the advantages of taking part?

If you are selected it is completely up to you to decide whether or not to take part in the study. If you do not want to take part you will be free to withdraw at any time without giving a reason. The Life History Interview and Cycling Observation and Interview are designed to be engaging and enjoyable. By taking part you are increasing understanding of cycling and helping to inform decisions about how we can better design places and cycle technology for an ageing population.

You will have the chance to connect with other people taking part in the study. Participants who complete the Life History Interview will be offered a £10 gift voucher. An additional £10 voucher will be offered to those completing the cycle ride observation and interview.

2 of 4 | INFORMATION SHEET

Figure 4. Example participant information sheet

	Oxford	Reading	Bristol	Cardiff	Total (% Female)	Ave. age (SD♦)
Biographical Interview only	16	19 ♀	13	16 ♀	64 (60)	65 (9.3)
Mobile Observation-Video Elicitation Interview (VEI)	20	16	24	35	95 (45)	63 (7.8)
Cycling & Wellbeing Trial (E-bike & Pedal)	38 * (19 & 19)	39 * (20 & 19)			77 (53)	62 (7.0)
Total (% Female)	74 (66)	74 (46)	37 (49)	51 (41)	236® (52)	
Ave. age (SD♦)	65 (8.9)	63 (7.7)	64 (7.9)	60 (6.7)	63 (8.1)	

Table 4. Participant set for each case site

- A further 9 participants who were recruited for Mobile Observation & VEI at the Cardiff (7) and Reading sites (2) were unable to take part and only completed a biographical interview
- * A further 12 participants who were recruited for the Cycling and Wellbeing Trial at Oxford (10) and Reading (2) were unable to take part and only completed a biographical interview.
- A further 20 participants were recruited but were subsequently unable to take part in any aspect of the study.
- ◆ SD (Standard Deviation). A small SD indicates that data points are clustered close to the mean (average). A large SD indicates they are spread from the mean.

participants based on the three age categories and sex as well as varied social-economic backgrounds. The average age of the final set of 236 participants that was selected to take part in the study was 63 years (**Table 4**). There was an even split between sexes across the sample – a higher proportion of males took part in mobile observations whereas the opposite was the case for biographical

interviews and the cycling and wellbeing trial. Ninety five per cent of participants classified themselves as white ethnicity. The majority were from the second least deprived quintile and around 90 per cent had access to a car at their household.

Approach and Methods

Cycling Biographies

One of the primary motivations for the cycle BOOM study was recognition that ageing can present some distinct challenges which can lead to people ceasing to cycle or being deterred from taking up cycling again. Ageing is considered as a combination of life-long biological (personal capabilities), psychological (personal perceptions of capabilities) and social processes (perceived opportunities and support) that individuals encounter in specific cultural contexts. With this in mind, all 236 participants in the cycle BOOM study took part in semi-structured biographical interviews (Lanzendorf, 2010; Chatterjee et al 2013) generating some 179 hours of audio-recorded material. This approach enabled a broad understanding of how people engaged with cycling in their lives (i.e. their ‘cycling trajectories’) within the context of where they have lived and worked and also the influence of family and wider social relations. Participants completed a life history calendar detailing key events in the life course (i.e. changes in housing location, education, work, mobility etc.) and engagement with cycling prior to undertaking an interview with the researcher (**Figure 5**). This allowed the researcher to familiarise themselves with the details of the participant’s life history and cycling engagement and also primed the participant to think about how their cycling unfolded, prior to the interview. The calendar was also used in the semi-structured interview as a visual aid to discuss past, present and anticipated future engagement with cycling. In some cases, where internet connection allowed, Google Street View (GSV) was used to view past and present residential locations and encourage the participant to discuss how residential context influenced their mobility and willingness to cycle. For those participants still cycling, the interview concluded with the researcher asking to look at the participant’s cycle(s) and storage in the home (**Figure 6**). Interviews were conducted with a variety of participants with different experiences of



The key question and sub-questions driving this part of the investigation were:

How is ability and willingness to cycle shaped by individual life events such as family and social relationships, employment and wider social, economic and technological change?

What are the different cycling trajectories?

What are the reasons for cycling cessation, continuity and re-engagement?

What are the recurring themes about cycling (including its role in people’s lives and how changes are made to cycling as people age)?

Year of birth: 1951	1950s	1960s	1970s	1980s	1990s	2000s	2010s
Residence	Family home in a rural area with a garden	Family home in a town	Family home in a city with a garden	Family home in a city without a garden	Family home in a city without a garden	Family home in a city without a garden	Townhouse
Household	Parental home with 1 child	Parental home with 2 children	Own home with 1 child	Own home with 2 children			
Education / work (paid / unpaid)	Adult training at school	Adult training at school	Full-time education	Part-time work	Part-time work	Part-time work	Part-time work
Activities / hobbies / leisure	Bike riding, cycling and walking to school						
Transport	Family car						
Cycling - owned or had access to a bike	From the time I was young						
Cycling - activity	From the time I was young I enjoyed it			From the time I was young	From the time I was young	From the time I was young	From the time I was young I enjoyed it

Figure 5. Example of completed Life History Calendar



Figure 6. Investigating cycle storage at the home
(Photo: cycle BOOM)

cycling in order to identify different cycling trajectories and written up as case summaries chronicling life events together with changes and continuity in cycling and the participant’s reasoning of them.

(Velo)Mobile Observations and Video Elicitation Interviews



Shadowing people on the move, while demanding, provides a rich insight into their practices and experiences of mobility in contemporary life (Czarniaswska, 2007; Spinney, 2011). A total of 95 participants who were currently cycling at the time of the biographical interview were invited to take part in a mobile observation and follow-up video elicitation interview. At the Bristol and Oxford case sites, this involved a researcher shadowing 44 riders while they made a pre-specified regular cycle journey of their choice (**Figure 7**). At the Cardiff and Reading sites a different approach was used where the research team, in partnership with the local stakeholders, selected a predefined route with a variety of physical characteristics (e.g. on road cycle lanes and off-road cycle tracks) and 51 participants were asked to navigate their way along it. The route that participants were asked to cycle in Reading whilst largely flat attempted to reflect the variety of urban types and topography including traffic-calmed residential streets, large ring road junctions, shared use alongside the canal, and busy shopping streets. It also included places where cycle-specific infrastructure had been implemented (for example the junction of Craven Road and London road) (**Figure 8**). The route that participants were asked to cycle in Cardiff was specifically designed to take in a variety of urban road types. It included cycle-specific infrastructure (for example the cycle lane on North Road and the Jug Handle junction at Cowbridge Road East), sections of larger road (A4161 Castle Street), Bute Park, and quiet residential streets (for example the Riverside area) (**Figure 9**).

Both participant and researcher cycles were fitted with action video cameras to capture footage of the journey from multiple angles/perspectives and a GPS device to trace the route (**Figure 10**). At the Cardiff and Reading sites participants were also fitted with a wrist-worn Galvanic Skin Response (GSR) (**Figure 11**) sensor in an attempt to identify and measure points of 'emotional arousal' (e.g. stress and relaxation) along the routes. After the ride, the

The key question and sub-questions driving this part of the investigation were:

How do specific features of the built environment and cycling technology affect cycling experience among older people and what is the impact on wellbeing?

How does 'moment-by-moment' wellbeing unfold when moving around by cycle?

What factors/design elements support or detract from wellbeing when moving around by cycle?

What strategies and tactics are employed by participants when moving around by cycle in order to maximize wellbeing?



Figure 7. Velo Mobile Observation/Shadowing
(Photo: cycle BOOM)

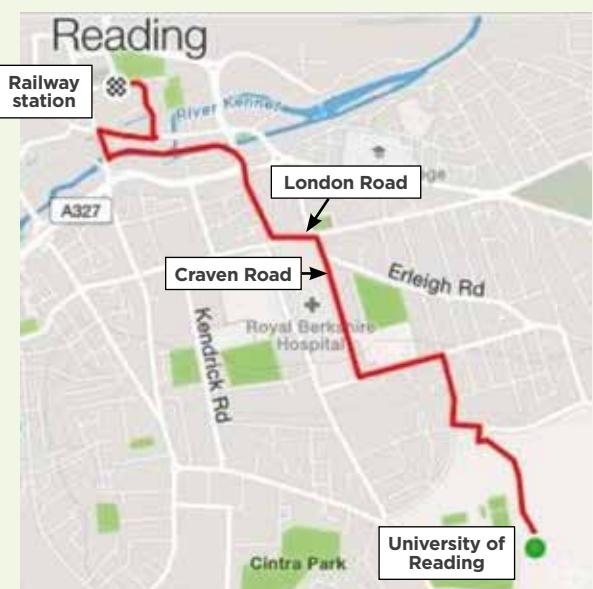


Figure 8. STRAVA trace of Reading route
(Source: STRAVA)



Figure 9. STRAVA trace of Cardiff route
(Source: STRAVA)



Figure 11. Wrist worn Galvanic Skin Response device (Photo: cycle BOOM)



Figure 10. Action camera mounted on bike handlebars (Photo: cycle BOOM)

video footage of the journey was played back to the participant as part of a video elicitation interview. This involved the researcher watching the video with the participant and using it as a prompt to gain detailed insights into route choice rationale and experience, the strategies and tactics employed when cycling and the feelings that arose throughout the journey (**Figure 12**). Synchronized GPS/GSR data was later combined with material from the video elicitation interviews to provide participant narrative accounts of 'moment-by-moment wellbeing' while riding through the built environment (**Figure 13**). Combined mobile ride video footage and video elicitation interview footage constituted over 100 hours of material for analysis. This together with life history interview data provided a holistic understanding of how participants' past cycling experience shaped current cycling behaviour and practice.



Figure 12. Video Elicitation Interview
(Photo: cycle BOOM)

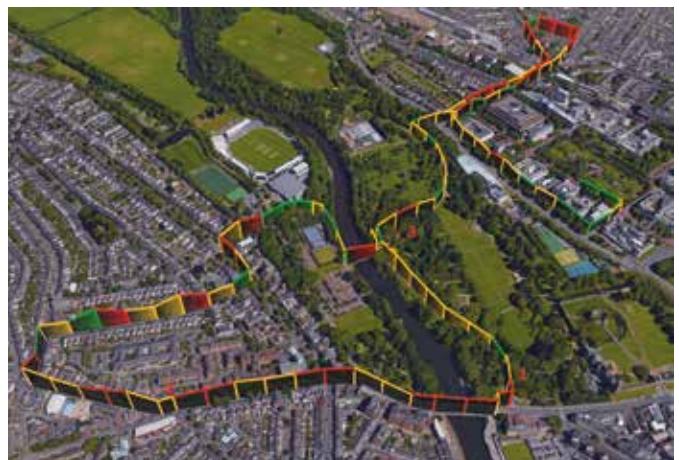


Figure 13. Representation of on-screen GSR data (Map data ©2015 Google)

Cycling and Wellbeing Trial

Studies have shown that regular exercise improves cognitive processes such as memory, attention, speed of processing, spatial reasoning (**Figure 14**) and particularly what we call ‘executive function’ in older adults (see Colcombe & Kramer, 2003, for a meta-analysis). Executive function is defined as those mental processes which are more complex to perform and require extra mental resources compared to hearing a sound or remembering one’s name, for instance. Executive function comprises processes such as maintaining and switching of attention, ignoring irrelevant information, planning and keeping information or a goal in mind, and mental flexibility (**Figure 15**).

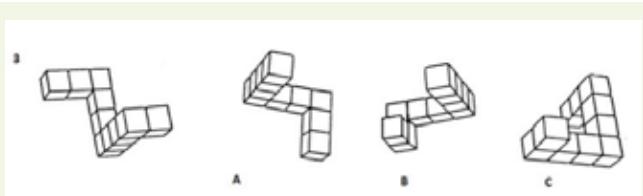


Figure 14. Spatial Reasoning: Example of shapes employed in the mental rotation task together with the question, “Which of the lettered figures matches the numbered figure exactly in shape but differs in orientation?”

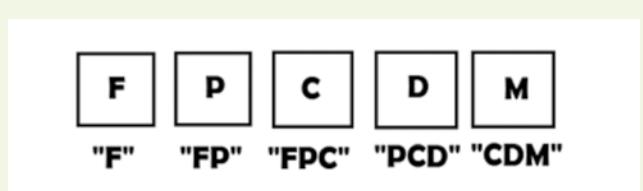


Figure 15. Executive Function: Example of the letter updating task (Source: adapted from Morris & Jones, 1990)

A sequence of letters is shown with each new letter appearing one-at-a-time. For every new letter that appears on the screen, the participant is required to say the last three letters they have seen, including the one currently on the screen. The boxes represent each screen the participant sees and the quotation marks indicate the correct verbal response.

The key question and sub-questions driving this part of the investigation were:

To what extent does cycling improve older people’s cognitive function, eudaimonic wellbeing (human flourishing), hedonic wellbeing (life satisfaction) and physical health?; and, how do specific features of the built environment and assistive technology (pedal vs e-bike) affect cycling experience among older people and what is the impact on wellbeing?

What was the impact of the cycling trial on wellbeing and cognition indicators?

What was participants’ experience of cycling over the course of the trial and how did this affect wellbeing?

Findings from previous studies were primarily obtained by participants acting in a controlled environment such as the gym. However, improved wellbeing in older adults has also been positively associated with performing activity in outdoor environments (Sugiyama & Thompson, 2007). The focus of the cycling and wellbeing trial was to investigate whether cycling in the outdoor environment would help older adults in terms of feeling better, happier and more engaged with life, as well as improving cognitive processes

A total of 77 adults aged between 50 and 83 years of age who reported that they had either done no cycling in the past five years, or that their cycling had seriously diminished over that period, took part in the trial at the Oxford and Reading case sites. This involved first undertaking a cycle training assessment/skills development programme with an accredited trainer (**Figure 16**) and then cycling outdoors for at least 30 minutes, three times a week over an 8-week period. Participants either rode a conventional pedal cycle (38) or an electrically assisted e-bike (39) (**Figure 17**). Before taking part in the 8-week trial participants undertook a number of tasks commonly used in neuropsychology to assess mental abilities, with a focus on ‘executive function’, and completed questionnaires to



Figure 16. Cycle assessment and training with qualified instructors (Photo: cycle BOOM)



Figure 17. Raleigh Motus e-bike used in trials (Photo: Raleigh UK)

assess their wellbeing, life satisfaction and physical health. Participants were also asked to complete a Diary of Cycling Experience (DoCE) (**Figure 18**) over their trial period, recording the type, number and duration of rides and to ‘...record reflections on your experience at the end of each week’. Those using the e-bikes also recorded the level of power assistance used during rides.

A total of 70 participants completed factual information about their journeys, and of these, 62 also wrote about their experiences - only 7 participants failed to provide any diary information. After the 8-week trial, participants repeated the initial tests and submitted their diaries. A selection of 9 pedal and 7 e-bike participants also took part in two separate post-trial focus group discussions to understand more about their experiences. In order to control for practice effects, a group of 22 control participants who were not cycle users and pledged not to cycle during an 8-week period also completed pre-and-post trial tests and kept a diary of their physical activity. Data analysis tested the hypothesis that pedal cycling and e-biking benefits cognition and wellbeing but that this benefit is not only related to the act of exercising, but also engaging with the outdoor environment. A thematic analysis of the focus group discussion and the DoCE provided a rich insight into the types of cycling participants engaged in and how their experiences unfolded during the trial. Finally, an online exit

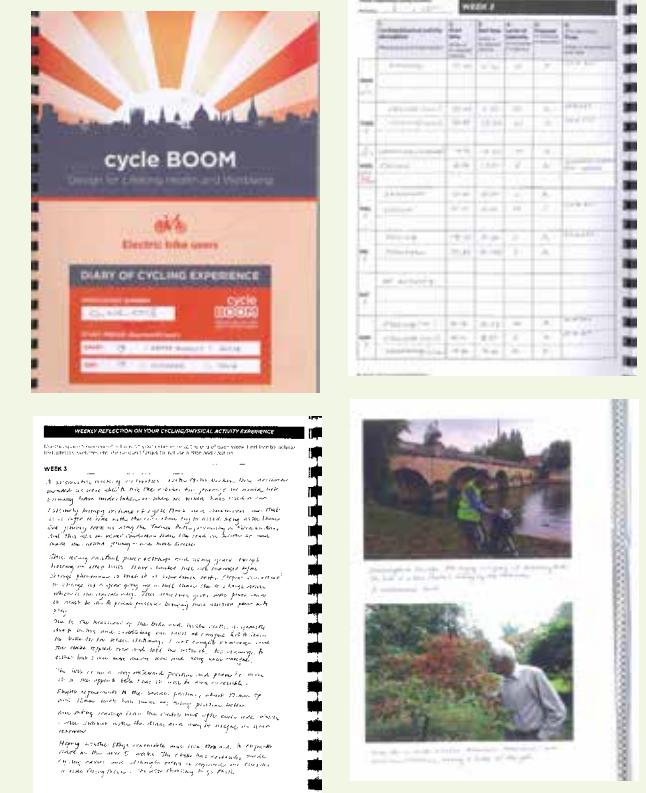


Figure 18. Diary of Cycling Experience (DoCE) capturing details of use (above) and reflections on use (below) (Photo: cycle BOOM)

survey of all 77 participants conducted several months after their trial had finished, gauging the extent to which participants were still engaged in cycling, was completed by 73 participants.

Cycling Biographies

THE BIOGRAPHICAL INTERVIEWS REVEALED

DIVERSITY in the cycling histories of the participants. We have simplified these life histories by placing participants into three main groups according to their engagement in cycling (or cycling trajectories) in the last five years (**Figure 19**).

Cycling Trajectories

First, **Reluctant Riders** who had not cycled in the last five years or had either stopped or substantially decreased their cycling; second, **Resilient Riders** who had been cycling consistently in the last five years or who had increased their level of cycling over this period; and third, **Re-engaged Riders** who had started cycling in the last five years after a hiatus in adult life or who had not cycled since childhood. Examining the characteristics of those in these groups helps to understand the factors which discourage and motivate cycling and which build resilience in cycling or lead to cycling being precarious.

Reluctant riders included those who had become accustomed to using the car or other methods of transport since their youth or early adulthood (See vignette: Dexter, 70s, Bristol on page 18). They seldom cycled and said they did not enjoy cycling. If they did cycle it was on holiday on traffic-free routes. We also spoke to people who had done some form of cycling prior to stopping in the last five years, but it was noticeable that their cycling had usually been sporadic and had not led to confidence to cycle in a range of environments (See vignette: Jodi, 60s, Oxford on page 18). For them, cycling had tended to ‘fizzle-out’ due to a sense of increased vulnerability cycling in heavily trafficked environments or to stop abruptly because of the onset of a health condition. Bikes were often disposed of because they were not well-suited and took up too much

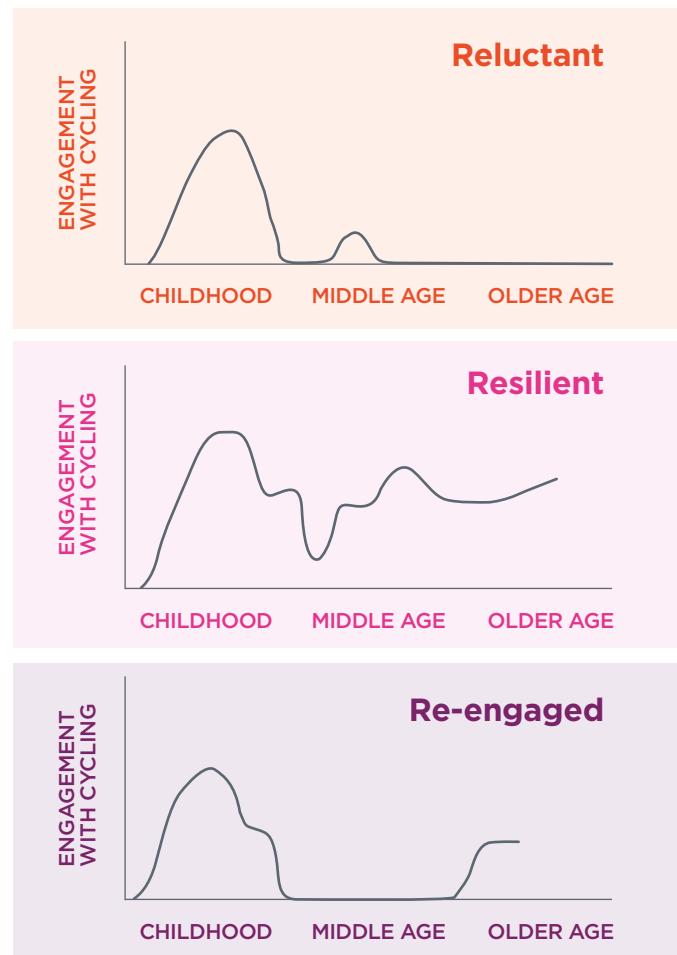


Figure 19. Illustration of cycling trajectories

space at home (See vignette: Floria, 60s, Bristol on page 19). There were some who had cycled more substantially during their working lives but cycling became displaced when the workplace became more distant or when they retired and did not cycle in their post-working life routine. The loss of others to cycle with could also contribute to cycling ‘fizzling out’. Although some participants felt encouraged by others to cycle this was insufficient for them to restart. The overwhelming majority of people in this group regarded cycling as a good form of exercise but stated that they would not contemplate cycling in current traffic conditions

because of safety issues. Those who said they might contemplate cycling often remarked that they would need support in the form of cycle training but undertaking training was not always successful in generating confidence to cycle (See vignette: Jodi, 60s, Oxford on page 18).

Resilient riders had accumulated cycling experience over long periods and exhibited a high level of autonomy and capability. Many of them mentioned that they had been brought up in cycling families. Cycling to work was a prominent feature of their cycling histories and this was more prevalent in the accounts of male participants, particularly where employment had been stable (See vignette: Jerry, 50s, Bristol on page 19). Commuter cyclists demonstrated the ability to adapt their cycling after retirement, finding new purposes, routes and times to cycle (See vignette: James, 70s, Oxford on page 20). Accounts of female participants often highlighted how family responsibilities and relationships meant that cycling had 'yo-yoed' and had typically lapsed upon becoming a parent but had restarted when children had grown-up or left home (See vignette: Fiona, 70s, Oxford on page 19). Among the group of resilient riders were both those who used their cycles solely for recreational activities in their local area, typically along traffic-free paths or low-trafficked roads, and those who used their cycles for utility journeys, content to cycle in a range of environments. In the latter category were a small number of participants who had not learnt to drive a car, or did not wish to drive a car, and who cycled as their main means of mobility and appreciated the greater flexibility than offered by local public transport (See vignette: Lindsey, 70s, Oxford on page 20).

Re-engaged riders had restarted cycling following an absence, often of multiple decades, and were predominantly motivated by getting fit and maintaining health. This group included a subgroup of retired males for whom the transition to retirement, often in conjunction with onset of health issues, led to a desire to become more active in older age (See vignette: Lance, 60s, Bristol on page 21). For women,

newfound freedom coincided with the end of child or other caring responsibilities, and a desire to become active had also prompted a return to cycling (See vignette: Patricia, 70s, Bristol on page 21). Restarting cycling was often encouraged by a partner who cycled, although differences in cycling ability could lead to this being precarious. Changing housing situations also opened up opportunities to cycle when residences were seen as supportive of cycling. Cycling almost exclusively took place along off-road paths and quiet roads in the surrounding neighbourhood when the weather was fine and outside of busy periods. A small number of re-engaged riders had been incentivised by a positive workplace culture towards cycling, coupled with largely traffic-free access between home and work. A key question for this group is whether their re-engagement with cycling will be sustained and whether confidence will develop to expand cycling domains.

Ageing & Changing Life Circumstances

The cycling histories showed how ageing and changes in life circumstances influence cycling. Changes in engagement with cycling were usually linked to changes to life circumstances relating to health, family, employment and housing. Reflections on how the ageing process had affected capacity to cycle were rich with descriptions of physical ailments, diminishing sensory capacities and acute and chronic medical conditions. Health limitations had often been the primary cause of curtailment of cycling or were a fundamental barrier to any further engagement with cycling (See vignette: Andre, 50s, Bristol on page 22). Some of those who continued to cycle deliberated over their capacity to continue to cycle, while others were confident that their experience and skills put them in good stead to carry on. For those re-engaging with cycling, it was seen as a suitable form of physical activity because of its low impact on joints and the ability to moderate intensity of effort. Participants had started cycling to help with weight control, cope with cancer treatment and respond to insomnia, the menopause and depression. Some participants had been encouraged to take up cycling by

partners or other family members and were even bought bicycles to do so (See vignette: Wilfred, 60s, Bristol on Page 22). Participants who had experienced the onset of health and physical function changes had adapted their riding, for example, by avoiding difficult manoeuvres and exercising more caution when riding on the road (See vignette: Alfie, 60s, Bristol on page 22). They had also purchased new lighter cycles with a wider range of gearing and had adapted bicycles, for example, by adding mirrors to assist turns. In a few cases, participants talked about how they had learned to be more assertive when riding in traffic.

Starting and ending relationships and the health condition and motivation of a partner could trigger a change to cycling. For some participants having someone to cycle with was integral to their cycling, while others were happy to cycle independently. For example, becoming a grandparent had prompted some participants to engage more with cycling in order to help their grandchildren to cycle. The transition from paid employment to retirement also presented an opportunity to cycle as part of a range of activities and interests. There were a few examples of couples moving home to live nearer green space so that they could engage in outdoor activity including cycling. Male and female participants often mentioned that they had enjoyed sport and physical exercise when younger and cycling enabled them to continue to be active. Males tended to engage more with organised group recreational rides in the countryside, whereas female participants tended to engage in less structured leisure cycling with a friend or partner on traffic-free routes in their local area (See vignette: Patricia, 70s, Bristol on page 21).

Contrasting Settings

The interviews revealed how residential settings facilitated and deterred cycling. Traffic conditions, physical attributes of an area, including topography and design of the built environment, together with the extent to which there was a noticeable cycling culture, were all perceived to play a role in propensity to cycle.



In **Bristol**, parking difficulties and congestion discouraged driving and encouraged functional cycling. In inner Bristol routes were 'manufactured' using parks, residential complexes and underpasses to circumvent busy transport corridors. Few participants referred to cycling into and across the city on arterial routes. In outer areas of Bristol and surrounding communities, off-road cycle paths were well used both for functional journeys and recreational cycling, although not always highly regarded aesthetically. Workplace cycling promotion and the encouragement of colleagues had led to taking up cycle commuting late in working life. Many participants had joined with family members in the annual city bike ride (Bristol Biggest Bike Ride), had used National Cycling Network routes (especially the Bristol and Bath Railway Path) and locally designated routes and there was awareness of organised cycling groups, although some scepticism towards them. In dense, inner areas of Bristol homes had confined spaces for storage that affected the ease of using bikes (**Figure 20**). Bristol's characteristically hilly topography meant that gradient was seen as an unavoidable part of cycling in the city. Some talked of accomplishing a particular hill on their journey as a matter of pride, while others confessed that sometimes the prospect of a particular hill deterred them from cycling.



Figure 20. Confined space for storing cycles affected ease of use (Photo: cycle BOOM)



Oxford

In **Oxford**, congestion in the city centre and on arterial roads, lack of permeable streets for private motor vehicles and the pressure for car parking discouraged driving, although some participants had reserved car parking which they exploited. Most Oxford cyclists discussed the general ease and efficiency of getting into the centre and around the city by bike, while traffic-free routes through natural spaces (river and canal-side paths) were particularly valued as a setting for cycling that was less harried and had more visual appeal. Some participants highlighted the barrier of Oxford's ring road for journeys to and from areas beyond the ring road. However, some participants appreciated the safety of the wide separated cycle path running next to it. There was some criticism of the inconsistency of the cycling environment on some of Oxford's arterial roads with, for example, fragmented cycle lanes, the domination of buses and challenging junctions. In the neighbouring town of Abingdon, the shared use path on the ring road and connection to a National Cycling Network route were appreciated. No cycling events other than Ride and Stride were mentioned in Oxford. Organised cycle groups had been tried by a few participants but generally found to be unsuitable due to a fast pace. Oxford's hills which lie to the east and west of the city, either side of the river, deterred some participants from using their bikes more extensively for their travel.



Reading

In **Reading** the presence of a number of wide and fast 'urban motorways' - most notably the A33 and A327 - coupled with a lack of high quality infrastructure served to discourage

cycling. Reading cyclists appreciated riverside and canal paths and also cycle-specific initiatives where they exist, such as the A4 Bath road cycle track and cycle-specific lights at the junction of Queen's Road and Watlington Street, but most avoided the city centre where possible.



Cardiff

In **Cardiff**, the combination of compact city centre, flat topography and numerous green spaces, provide features that should help to encourage cycling. However, the city also suffers from having a mix of central pedestrianised streets and large car-centric roads (for example the A4161 and A4160) that serve to discourage cycling. Many Cardiff cyclists make use of green corridors particularly the Taff Trail through Bute Park to the Cardiff Bay area.

Cycling Practices, Benefits and Meanings

The interviews revealed the ways in which cycling was practiced by the participants and how it contributed to their lives. There were 'all-purpose' cyclists for whom cycling was their means of mobility and who were confident to cycle in different environments and had shown the ability to adapt their bicycles and riding practices as they got older (more commonly males). Cycling was preferred to other modes of transport due to being quicker, more reliable, flexible and cheaper. It also freed up a car for other household members who might need it. A small number of participants (more commonly females) did not drive or have access to a car and cycling enabled them to more effectively organise their key activities such as getting to work and offered more freedom of movement than possible with public transport. Despite this, they indicated limitations in how far they were prepared to cycle outside their local area. There were

participants still working who had taken up cycling to work with support from their workplace and from colleagues. Typically, cycling to work was undertaken on traffic-free and sheltered routes and was alternated with using other modes (depending on weather and season).

For many participants cycling was only practiced for recreation. This could be occasional recreational cycling on traffic-free routes accessible from home or by taking the bicycle by car to another location. Some cycled with support from a partner but others cycled on their own as they considered themselves too slow to cycle with a partner. Many participants expressed the wish to cycle more for recreation but lacked others with which to cycle. There were participants for whom recreational cycling was a scheduled part of their weekly routine with lengthy rides undertaken, in some cases alone, and in other cases with cycling groups (formal and informal). Some participants had developed many different routes in their local countryside. Many male participants returned to a form of cycling they had done earlier in life, including time trialling, organised cycle groups or exploring their local area on their own, with purchasing of high-value, specialised bikes for the purpose. Re-engagement amongst the female participants tended to be less structured and on a smaller scale, involving using the bike for local trips or arranging to ride with a friend or partner. Rides with friends and partners and more formal cycling groups tended to be organised around stops at favoured locations for refreshment.

Most participants who were cycling were positive about cycling's contribution to staying active and compensating for sedentary jobs/lifestyles. Many of those continuing to cycle, and returning to cycle, incorporated cycling in personal or shared projects to be physically active and enhance health. Some participants who were experiencing difficulties with their joints had found cycling to be more comfortable than running. There were participants who were very positive about how cycling had helped them cope with

physical and mental health problems. Both male and female participants mentioned that they had enjoyed sport and physical exercise when younger and cycling enabled them to be active again and was more enjoyable than other physical activities. It was clear for many participants that cycling gave them a sense of achievement.

Those cycling in urban areas valued parts of their route which allowed them to let their concentration dip, enjoy a particular view or focus on pedalling rather than traffic. There was also talk of the benefit of having time for reflection and a separate interest to a partner. For some of the more elderly participants cycling enabled them to maintain a personal connection with the area in which they lived and fellow residents. Finally, some participants took pride in encouraging others to cycle, whether this was children, grandchildren or colleagues at work. In the following section more specific insights are provided on the places where participants cycled, their experience of cycling and their interaction with different features, and users of, the built environment.

Vignettes

Reluctant Riders

Dexter, 70s, North Fringe of Bristol

Dexter's sole cycling experience was confined to his youth when he lived in a town situated in a valley in south Wales. Due to the challenging topography the journeys he cycled were confined to routes along the valley floor. His cycling diminished when he started work at a factory and he travelled, as everyone else did, by bus. He got a car soon after becoming eligible and his travel had remained largely car-based ever since. Dexter thought these experiences had given

him the impression that cycling was impractical and something he recalled as physically uncomfortable.

In the 1980s he moved to a suburban housing estate in Bristol where he continued to almost exclusively drive. He didn't think he had given any thought to trying cycling in the city, adding that his shift pattern and awareness of bike thefts from work would have been a deterrent. He recalled the installation of cycling facilities. Dexter was now a widower and retired. He saw driving as integral to his routine of activities, clubs and hobbies

as well as family relations and responsibilities, for example, seeing his partner and picking up his grandchild. He had no expectations of cycling again and imagined he would be "*really quite frightened*" cycling in Bristol. After three decades of generally moving around the city by car and no experience of cycling, Dexter seemed to have developed negative impressions of cycling behaviour and safety of cycling in Bristol. However, he imagined a scenario where Bristol had a network of cycle paths that avoided crossing main roads where he would be more likely to use an electric bicycle.

Jodi, 60s, Abingdon (small town south of Oxford)

Jodi had cycled to school and around the town where she grew up into her teens. She stopped cycling when a student in London and then started driving to commute for her first job. Since then the car had remained her primary means of transport. She had continued to cycle locally on an occasional basis for leisure with her husband at a variety of residential locations in London and southeast England. This was despite not feeling at all confident cycling on roads with traffic and classifying herself as "*not a very good*

cyclist". The companionship of cycling with her husband had been important - when he was away with work she had tended to do far less cycling. Jodi had ridden to work at times when it was close-by and accessible along quiet or off-road routes and she felt her employers were supportive. This low level of cycling had petered out after she retired from work four years ago and coincided with her son leaving home for university and her feeling that she had fewer opportunities for social cycling. Having put on weight, Jodi was aware of the need to get more exercise but did not use her

static exercise bike due to "*laziness*" and was prevented from cycling by the condition of her bike and reduced confidence. She was positive about the potential of e-bikes but was concerned it might be a waste of a considerable amount of money if she did not end up using it. Jodi had signed up to the cycle BOOM Cycling and Wellbeing Trial to help her with the motivation and skills to re- engage with pedal cycling but was also interested in trying out an e-bike. However, cycle training and the loan of the e-bike was not sufficient for Jodi to feel confident cycling and she withdrew from the trial.

Reluctant Rider

Floria, 60s, Bristol suburbs

Floria was prompted to cycle again in her mid-forties by her husband who she described as a “keen cyclist”. Prior to that she had not thought much about cycling because none of her peers cycled. Cycling was exclusively a leisure activity on holidays until in her early sixties when, “on a whim”, she got herself a second hand bike. In the 4 years she had the bike she rode some traffic-

free routes around Bristol, taking the bike by car to get there, and made a few trips to the local leisure centre but generally dismounted and walked the bike across junctions. Eventually the “faff” of dismantling the bike to take it to traffic-free routes by car and the feeling it was underused meant she got rid of her bike. Floria no longer felt capable of cycling in Bristol and described herself as “wobbly” and a “wimp”. She felt reluctant to join a

“silver cyclists group” for fear that she would hold them up as they “whizzed through major junctions”. While on holiday abroad during the previous year she had cycled a power assisted ‘e-bike’ and enjoyed the experience of being able to pass her husband on hills. She hoped her cycling would continue as a fun, holiday activity but expressed uncertainty whether this would be the case.

Resilient Riders

Jerry, 50s, North Fringe of Bristol

Jerry had cycled to work throughout his career since starting as an apprentice electrician at sixteen. Having always lived and worked in the north fringe of Bristol his cycle commute had

remained through familiar territory. When he wasn’t travelling with other family members he often used his bike for other journeys around Bristol. He had joined a group of retired colleagues on a monthly recreational ride when he could fit it in and had done some trips

further afield with his son. Jerry described cycling as “a drug”, something he had to replace with a walk if he was ever away without his bike. He recalled a difficult time in his life when cycling had been a time to relax, think things through, and this had, he felt, kept him going.

Fiona, 70s, suburban Oxford

Fiona summarised her cycling life history by saying that she had done more cycling as she got older. She had three distinct phases of cycling. She had cycled increasingly as a child and teenager before dropping to nothing when she had her first child. Her cycling

had then built up once more as the whole family had bikes and cycled, she then had more time to cycle as the children became more independent. Her cycling had ceased again when she left her husband (and bicycle) in her early 40s. She then had a period of 7-8 years of doing almost no cycling as she worked very locally

and didn’t have a bike. Her cycling picked up again when she started work in the centre of the city and was given a bike. Her cycling increased further when she retired as she had as she had more time to cycle, appreciating it as a reason to get out of the house and to experience freedom.

Resilient Riders

Lindsey, 70s, central Oxford

Lindsey's cycling had increased from childhood until her sixties and was still continuing at a high level. Having appreciated the freedom of cycling as a child in North London she had cycled for transport in Oxford as an undergraduate. Being able to choose to live close to work enabled her to commute by cycle and she had commuted in a range of locations before returning to work in Oxford. Her cycling increased further when her car broke down unexpectedly and she

realised that, living in central Oxford, she didn't need to own one. Lindsey acquired three bikes each to use for different purposes, one of which was a 'shopper' that she often took on the train when traveling around the UK for work. She also increased her leisure riding doing longer charity rides and holidays in Sweden, Spain, New Zealand and the USA. In her early 60s she started spending more time in Australia and her cycling had declined slightly despite buying two bikes to use there. She anticipated that, in the period she described

as her "*middle-youth*", she hoped to continue cycling at a similar rate into her 80s – she had already organised a 100-mile ride to celebrate her 75th birthday! Lindsey found that Oxford was a city that was not that pleasant or enjoyable to cycle in. In fact she regarded cycling in Oxford as purely functional in comparison with the fun and pleasure she got from cycling in the UK countryside and the challenges and risks that she relished when cycling in the Perth hinterland in Western Australia.

James, 70s, Abingdon (town south of Oxford)

Cycling had been a consistent part of James's life and was on an upward trajectory. He grew up in Abingdon, cycling in the town with his brother and friends before joining a cycle club for leisure rides. James then used a bike to commute to a series of jobs in the Abingdon area and cycled with his wife and two children when they were younger. His cycling expanded with the purchase of a mountain bike to ride off-road. He continued to cycle after acquiring a car that he used to travel to

work further afield for a period. Disposing of the car in the mid-90s as it was expensive to run he then used motorbikes and scooters in addition to his bikes. James had a hip replacement in 2001 that he had to have replaced again in 2012. In both cases he was advised by the physiotherapist to do more cycling because it was a non-weight bearing exercise. From 2003-2011 he cycled to work in south Abingdon but he had a serious cycling accident in 2007 on his way to work a night shift. This required taking two weeks off work but he persevered and continued to cycle on

the same route to work. Since retirement in 2011 he has cycled more than ever, particularly in the local area, preferring to use cycle paths, tracks and lanes where possible to explore areas around Abingdon. He does little social cycling but cycles with his great-grandson to help him gain skills. James anticipated that he would continue cycling at the same level as he does now, in similar areas. He appreciated the enjoyment and freedom cycling gave him to explore the countryside where he could connect with nature, relax and enjoy the fresh air.

Re-engaged Riders

Lance, 60s, Yate (town north-east of Bristol)

After cycling competitively and also using a bike as a principal means of getting around in his youth and early adulthood, Lance took a break from cycling as he entered his thirties because of a move from outer London to Yate and change of job where cycling to work was less feasible. Lance has also become more aware of cycling fatalities

and he regarded Yate as too risky for cycling to work, particularly as he now had responsibility for a family, stating: *"I had a young family and the number of people I'd heard about getting killed, it just didn't feel safe...It felt more dangerous cycling around Yate even though all the people I'd heard about had been killed in London it felt like drivers were more aware of you there...there was a different mentality."*

With the exception of two 6-month periods when he trained for two cycle challenges his cycling was absent until retirement which he used as an opportunity to get back on his bike. Lance had four bikes and a routine of cycling three times a week with the University of the Third Age and another older people's cycling group. He had taken part in a number of organised cycle rides and had others planned.

Patricia, 70s, Yate (town north-east of Bristol)

Patricia returned to cycling in her forties having used a bike in youth and occasionally at the start of her working life. She hadn't given any consideration to cycling in the intervening years, adding that she thought it would not have been practical for her as a mother living in Luton.

When her children were a bit older she lived in a small town in the Greater Bristol area and had a job that entailed

moving around the county. She bought a bike to get some exercise and to get outdoors, having found she didn't enjoy classes at the gym: *"I wanted to be doing something that was outside so decided give cycling a go".* She initially rode circuits around the town mainly on the pavement and cycle paths alone three or four times a week. Subsequently her husband had joined her on these rides. Patricia didn't feel retirement had made any significant impact on lifestyle

and mobility because she was already walking with the local Ramblers Association and also cycling. Over the last few years Patricia had been riding once a week with a friend who didn't feel capable or inclined to cycle long distances with her husband. Occasionally Patricia rode to her daughter's house in Chipping Sodbury but generally her cycling was to keep fit and get out and about.

Ageing and Changing Life Circumstances

Andre, 50s, North Fringe of Bristol

After limited cycling as a child, Andre got a bike in his thirties to take part in sports events with a cycling club. He used it occasionally for trips around his local area in London but mostly walked and used public transport. He moved to live and work in the north fringe of Bristol when he was in his late

thirties (1990s). This was the first time he owned a car but the congestion in the area prompted him to commute by bicycle. Andre was aware at the time that his employer promoted sustainable travel. In addition to commuting he used the bike for other trips and occasionally to participate in cycling events. Andre stopped running and then his cycling reduced

after arthritis developed in his hips and he had a minor stroke a few years later. Andre was planning to sell his bike but was thinking about replacing it with one with a step-through frame. He was uncertain whether he could resume commuting but thought he might join a community cycling group and start to make journeys by bike to the local shops.

Wilfred, 60s, North Fringe of Bristol

Wilfred used a bike to get to work for a short spell in his late teens but had not cycled for the majority of his working life. Opportunities to cycle for transport were slim because of the distance between home and work coupled with the logistics of running his own business that required use of a van. Wilfred had played sport competitively until the deterioration of his knees forced him to stop. He

felt the hours and focus he'd devoted to his business had excluded any possibilities of cycling. Wilfred's wife had taken up cycling for fitness and charity rides in the 1990s and was instrumental in getting him to cycle again and into the routine of cycling together. This took place as Wilfred was approaching retirement and was in the process of having his knee reconstructed. From short rides with his family this had developed into going

on cycling holidays with his wife and friends and also twice-weekly local rides.

Wilfred had moved with his wife from the suburbs to the north fringe of Bristol after retirement. Wilfred was only prepared to cycle on roads to a very limited extent and he and his wife felt that the move had been positive in giving them access to more opportunities to cycle off-road on traffic-free routes.

Alfie, 60s, Bristol suburbs

Alfie had cycled to work almost continuously through his working life and his commute pattern had remained fairly consistent. He had also been mountain biking with friends and on cycling holidays with his wife. Upon retiring, when not travelling with his wife who was too afraid to cycle in

traffic, he had been cycling to access various activities that he was involved in. They only cycled together for leisure or when on holiday abroad. Although he was generally unperturbed by cycling on arterial routes within the city Alfie was aware that his physical stamina had diminished following a respiratory illness a few years

earlier. He had adapted to this by making some alterations to his route to avoid gradients or dismounting and wheeling his bike when he needed to. Alfie thought that an electric-bike was a potential solution for the future when his fitness had deteriorated to the extent that he had difficulty riding a pedal cycle.

(Velo)Mobile Observations and Video Elicitation Interviews

THE FINDINGS FROM OUR MOBILE OBSERVATIONS AND VIDEO ELICITATION

INTERVIEWS were generated from Resilient Riders. These are people who have accumulated cycling experience over long periods and who had been cycling consistently in the last five years. Here we describe the timing of their cycling and where they cycle and also consider the strategies they employed when cycling to maintain comfort, safety and wellbeing.

When People Ride

In the previous section we highlighted how retirement is a time of increased freedom and the potential to cycle more. Retired participants we studied were often more flexible with their time and typically scheduled cycling to avoid busy periods. While journeys for work or volunteering were still undertaken at peak times, those for leisure, exercise, shopping and socialising were overwhelmingly undertaken outside of peak times. This was apparent at the Oxford and Bristol case sites where participants selected the cycle journey they wanted us to observe. Our observations also revealed the constraints on where that freedom can be enjoyed with many participants limiting where they ride in order to minimise journey stress and risk. So, for example, some would vary routes to and from the home in order to avoid busy junctions and having to make difficult manoeuvres (**see Box 1**).

Where People Ride – Interactions with Infrastructure

There is clear evidence from the accounts and observations of older cyclists (and particularly less confident cyclists) that cycling alongside

BOX 1

“This is a school along here...but usually my time is not clashing with that. That’s one lucky thing about being retired; you can pick your times!” (George, 70s, Bristol).

“Coming up to the junction which is a tricky one...a lot of problems...it is used as a rat run...staff going to the hospitals...because I am retired I can set out in the middle of the morning or afternoon [and avoid it].” (Abraham, 70s, Oxford).

motorised traffic is perceived to be a risky activity. The dangers posed by drivers of cars were often discussed but there was particular concern about riding among buses and heavy goods vehicles in inner-urban areas. Whilst this is not a ground-breaking finding, it is worth repeating not only because it reinforces findings from other studies (see for example Pooley et al. 2013), but also because this comes from a cohort who appear to have learned to cope with the dominance of the car and the paucity of cycle infrastructure. These arguments have been well rehearsed elsewhere so in this section we focus on the older cycling experience and the adaptations that cyclists make to cope with this situation. It is fair to say that participants across all four sites were also largely dissatisfied with the quality of cycle infrastructure provision on the public highway. Many had resigned themselves to having to perform manoeuvres such as dismounting at junctions or riding (carefully) along pavements in order to negotiate what they regarded as risky places. Below we highlight the key factors that detract from a positive cycling experience.

Sharing space

As older cyclists tended to use opportunities to cycle away from motorised traffic, a prominent issue was the experience of using shared-use paths with pedestrians and other cyclists. Rider narratives at all case sites suggest that participants are generally more relaxed and positive about sharing space with pedestrians, something they attributed to traffic-free and green environments.

However, many riders still related a level of uncertainty and anxiety in such places due to sharing the space with what they perceived as 'less predictable' forms of pedestrian activity, particularly young children and dog walkers. In Bristol this was, for example, with reference to the Bath and Bristol Railway path and various parks; in Oxford, with reference to the River Thames path and paths across parks and meadows; in Cardiff in relation to Bute Park; and in Reading to a section of the Kennet and Avon Canal. There were numerous instances through Bute Park in Cardiff, for example, where raised levels of stress indicated by GSR data corresponded with video observations and rider narratives of 'unpredictable' pedestrian activity. **Box 2** contains a selection of participant quotes that demonstrate the tension between the enjoyment of green spaces and anxiety generated by shared use. **Box 3** illustrates Timothy (70s, Cardiff) navigating his way through Bute Park, Cardiff and his interactions with pedestrians.

Traversing Surfaces

A recurring theme in participant narratives was the poor and deteriorating state of surfacing (**Figure 21**) and how this contributed to feeling distracted, uncomfortable and vulnerable (**Box 4**). Not only was poor surfacing deemed to be dangerous, participants also discussed how it distracted them from dealing with the dangers posed by motorised traffic, and also diminished their enjoyment of their surroundings. In fact, participants often pointed out smoother sections of their route as the exception rather than the rule. Vertical deflections such as speed cushions and rumble

BOX 2

"The first thing is knowing where these pedestrians are going to wander, so that's a generic thing about knowing your place. On anything with shared use, even if it's got a line on it, you're not sure of your place, you don't know if they're suddenly going to take off this way or that way...so you have to take the line with a chunk [sic.] of salt." (Zachary, 60s, Reading).

"Some older people who are a bit precarious and not very used to it would find it more hair-raising having kids running around...reactions slower...as with dogs darting around they would feel that they couldn't cope, so perhaps if you ask me in 10 years time I might not have the same view, but at the moment, I like to see that and feel it is a more natural situation." (Lynette 70s, Oxford).

"No dogs around today which on these sort of tracks can be... unpredictable, just have to go very slowly, I've never had a dog try and attack me but they are unpredictable in terms of how they move, and if they are attached on a lead to someone else!" (Cedric, 60s, Oxford).

strips targeted at reducing traffic speeds were also criticised for the unnecessary discomfort they caused. This has clear implications not only for cyclist safety, but also for wider issues around urban design and the potential for cycling to enhance wellbeing. For example, if surfacing is poor, or there are obstacles to navigate, it suggests that the visual amenity of the area will be diminished as riders are more likely to be focused on constantly scanning the surface ahead of them rather than enjoying their surroundings.

Navigation and Expected Manoeuvres

One of the key factors shaping cyclists' experience is whether they are clear of what is expected of them and the extent to which this aligns with their capabilities as a rider. Motorists are clearly directed towards what they are supposed to do in most instances;

Box 3 Timothy Negotiating Pedestrians in Bute Park, Cardiff

Enjoyable, just a pleasant feeling. [However] I felt with lack of definition that I could be cycling there. I thought people might be aware... But you have to go very slowly and zig-zag and you don't know if other people are going to walk in the way and step sideways. That's the thing that worries me the most.

HE REDUCED HIS CADENCE AND COASTED AS HE APPROACHED A COUPLE WITH A PRAM.



2

TIMOTHY APPROACHED A SHARED-USE PATH IN BUTE PARK.



1

IMMEDIATELY AFTERWARD, TIMOTHY SWERVED LEFT TO ACCOMMODATE ON-COMING PEDESTRIANS TO HIS RIGHT.



3

HE SLOWLY APPLIED HIS BRAKES.



4

HE SIGNIFICANTLY REDUCED HIS CADENCE WHILST CYCLING BEHIND A GROUP OF PEDESTRIANS.



6

CAUTIOUSLY, TIMOTHY SWERVED RIGHT...



5

AND THEN SWERVED LEFT AND THEN IMMEDIATELY RIGHT TO NEGOTIATE BETWEEN OTHER CYCLISTS AND PEDESTRIANS.



7

BOX 4

"This road surface is awful. Bumps everywhere as you can see... I have front suspension but it doesn't make any difference. It's the back...if it's a bad bump you get a real thump anyway. You need both hands on the handlebars!" (Stanford, 60s, Bristol).

"Road resurfaced last year - terrible before, very, very bumpy - and now you just feel much more secure on your bike. You know you are not going to take a tumble unexpectedly or, one of the nightmares is, that you are going to go into a pothole and fall off your bike. Otherwise your attention is distracted by watching potholes and the smoother bits which you can go on, and trying to be aware of the traffic, so you can't deal with two quite serious potential hazards. If the path is not good it just adds to your vulnerability and your potential dangers." (Desiree, 70s, Oxford).

"I just really hate bumpy things shaking me up and down, so I'm just irritated at this point. I often prefer to be on the road if the cycle path is in poor condition. I get shaken up by it so my body feels really uncomfortable on it, sometimes my head will hurt if I'm really shaken up, you know, just the whole bumpy thing." (Rebecca, 60s, Cardiff).

"There's nothing worse than going over those bumps. There's nothing worse. Howard Street is a nightmare. They're much higher...it jars your whole body really." (Ursala, 50s, Oxford).

"This is a newly resurfaced road, always pleasant to go on new tarmac as a cyclist. Quiets the bike down, smoother, you've got less worry about looking out for potholes or other defects in the road." (Pavel, 50s, Reading).



Figure 21. The poor state of surfaces was a recurrent theme (Photo: Ben Spencer)

routes have a coherence and legibility designed into them making it clear what the user should do next while this is rarely true for cyclists. Participants often pointed out situations which left them feeling uncertain about what they were expected to do leaving them to fend for themselves and employ their own logic of navigating spaces (**Box 5**). This often produced feelings of anxiety, frustration and vulnerability. When riding the predefined routes in Cardiff and Reading, for example, riders often either did not know how they should negotiate junctions, or were uncomfortable performing manoeuvres they thought were expected of them (**Box 6**). At these points along the route participant narratives of uncertainty and anxiety often aligned with raised levels of stress represented in GSR data (**Box 7**).

BOX 5

"It's not like a drive, is it, when you know you've always got a lane? On the bike you've got loads of different things, haven't you? Sometimes you have got to cross a pavement, sometimes you've got a cycle lane, and sometimes you're among the traffic, sometimes you're in a dangerous spot in the middle of the road. It's nothing like being in the car, is it?" (Sibylle, 50s, Cardiff).

"If that [points to painted cycle path] had a nice distinctive colour all the way across it would be much easier to read, it would really help...when you're here it's quite hard to read the far side of it so you can see there's maybe a traffic light you've got to read and you see that kerb and wonder what that does and I'm not at all sure because that's the pedestrian one right? So what's that cut through? It's probably for pedestrians going across there to be fair, but you'd probably be safer if that was all on the one level and it was distinguished by paint or setts. If that was a distinctive colour it would lead you through. It has the potential to be really good." (Zachary, 60s, Reading).

Breaking the Rules

There were many instances of older cyclists 'breaking the rules' with riders often eschewing specific cycle infrastructure provision where it was regarded as less convenient or less safe than other options. They would, for example, often get off and walk or cycle slowly on the pavement mimicking pedestrian movement. The video elicitation interviews provided an opportunity to discuss with participants the reasons for this behaviour (**Box 8 & Box 9 - 'Lindsey's Left Turn'**). Whilst it is all too easy to characterise rule breaking by younger cyclists as the work of 'hooligans', we argue that when older cyclists (many of whom discussed instances where they thought it made sense to behave illegally, but suppressed such behaviour because they wanted to maintain the identity of 'responsible older citizen' and/or 'experienced cyclist') also engage in such behaviours, such a narrative becomes much harder to sustain. What the data suggests is that such 'illegal' behaviours emerge because the differing capabilities of cyclists, and particularly older cyclists, are so poorly catered for in transport networks. Cyclists often feel they are safer or will be less of an 'irritation' to drivers if they do what 'feels' right rather than what is legally right.

Cycling Capability and Adaptation

The physical environment for cycling assumes a 'standard' user easily capable of a range of manoeuvres such as mounting/dismounting, turning the head and maintaining a 'vehicular' speed. Whilst many participants in the study reported being in good health and largely able to do these things, many were increasingly experiencing health issues affecting joints, eyesight and hearing, balance and flexibility. Due to a reduction in physical capabilities many older cyclists were finding it harder to perform the accepted range of movements assumed by infrastructure and bicycle designers. A common issue was difficulty turning the head to look over the shoulder, for example, before moving into the middle of the road to make a right-turn. Riders were also keen to point out their

BOX 6 Matthew (60s, Cardiff) negotiating a right turn from North Road to Corbett Road, Cardiff.

"This is one of the junctions which I tend to avoid. If it really is chaotic, I will get off and use the [pedestrian] lights, but it was quiet enough. It's not a road [Corbett Road] I would normally cycle down. I would try and avoid it because traffic tends to whizz down off the bridge and jump the lights. I thought it was quiet enough this morning to cycle up that bit of pavement and go across the junction... Sure, this is the quietest I've seen this junction for a while. There's often a lot of cars hanging around. So, it doesn't make this junction that comfortable as well because you've got to cut across, so even though you're keeping aware of the lights, it could be okay..."



Map data ©2015 Google

Matthew approached a main road after cycling along a pavement which he took to be a cycle path. Note the rise of GSR as the participant manoeuvred right.



Map data ©2015 Google

MATTHEW REDUCED HIS SPEED AND CAME TO A STOP AT THE JUNCTION.

1



WHilst STATIONARY, MATTHEW CHECKED FOR ONCOMING TRAFFIC ALONG CORBETT ROAD.

2



And you've got to get out onto this road.

THIS WAS FOLLOWED BY A GLANCE TO HIS LEFT TO CHECK FOR TRAFFIC ALONG NORTH ROAD.

3



This is one the junctions I tend to avoid.

HE REMOUNTED HIS BICYCLE AND CYCLED DOWN A PAVEMENT TO JOIN CORBETT ROAD.

4



Traffic tends to whizz down...

HE PROCEEDED WITH CAUTION AND CONTINUED TO LOOK LEFT FOR POTENTIAL TRAFFIC.

5



Often a lot of cars hanging around so it doesn't make this junction comfortable.

MATTHEW SIGNALLED RIGHT WITH HIS ARM.

6



It's uncomfortable as well because you've got to cut across.

I did check I had the lights with me otherwise I could have stopped.

7



BOX 7 Bio-sensing and Cycling

The use of bio-sensing in social and geographical research is still in its infancy. Accordingly we do not wish to unduly raise expectations of what its use might offer to the field of transport and mobilities studies. Whether using Electroencephalography (EEG) or Galvanic Skin Response (GSR) (as we have done in this study) there are numerous problems to overcome when using bio-sensing in real world settings. These can be summarised as issues with the ways in which the movement of the user in relation to the placement of the equipment affects the data gathered by the sensor – this is particularly a problem with mobile EEG sensors (Aspinall et al. 2015) – and the ways in which exercise (even gentle cycling and walking) raises skin conductance levels and stimulated response levels of skin conductance.

One of the potential benefits of using GSR is the ability to aggregate participant data from the way-marked routes in order to identify and geo-locate patterns of emotional arousal. However, an additional issue arises when we attempt to aggregate GSR data from a number of participants because GSR readings of each participant have a different baseline and response range and are, therefore, not directly comparable. In order to address this, participant data were allocated to ‘bands’ of high (red), medium (yellow) or low (green) emotional arousal using GSR data for each 50 metre section of route. These bands were allocated scores of 1,2 and 3 and then averaged across all participants to produce an average for each section. The average score was up-scaled by a factor of 20 simply to ensure the data was visible within the Google Earth environment. Having done this for each of the participants we have then remapped the aggregated data onto the route to show places where levels of emotional arousal were consistently high (indicating raised levels of stress), medium or low (indicating more relaxed states).

The map of the way-marked route in Cardiff (**Figure 22**) shows aggregated data from 21 participants, and illustrates that the relationship between emotional arousal and location is not straight-forward. However, there are locations where participants typically displayed higher levels of emotional arousal and which correspond to narratives of ‘uncertainty’ and ‘vulnerability’. Of particular note are the junctions of Bute Park and Castle Street (1), and the A4161 leading up to Cowbridge Road East (2), both places where participants typically expressed concern. The aggregated GSR data also suggest that whilst participants appear generally more relaxed in the traffic-free environment of Bute Park than on the roads (3), participants appear more stressed than we might imagine in such a place. In fact, a cursory analysis demonstrates that there are very few places on the route where all participants experienced low levels of arousal. Whilst the data requires further analysis, this aggregate data suggests that the potentially relaxing nature of cycling is not being realised.

BOX 8

"I'm going the wrong way (laughs) [and have you ever encountered any conflict?] not conflict, occasionally you find a car but I get off then or go on the pavement I mean I don't sort of obstruct anybody else, it's their right of way" (Angie, 60s, Bristol).

"The road isn't that busy today. When it's constant with traffic it can be quite intimidating. It's not a pleasant road to ride on or cross, hence the hesitation here because sometimes on these roads, these big distributor roads in and out of Cardiff, I'd even get off and cross as a pedestrian and then get back on if it's very busy." (Shay, 60s, Cardiff).

"I bike on pavements at roughly the same speed as I would walk...I know it's illegal, I do it because it suits me and I don't think I'm causing anyone else any harm... it's easier to bicycle slowly for 50 yards than it is to push a bike 50 yards; it is just physically easier" (Vivian, 60s, Oxford).

desire to maintain momentum and not having to stop because of the extra effort required to get started again. Some dismounted and walked up hills or pulled over to the side of the road and crossed on foot when making right turns. **Box 10** highlights some of the challenges of maintaining cycling.

Participants highlighted the variety of adaptations they had made to their cycles or cycling such as fitting mirrors to make up for a loss of flexibility in their neck, adjusting handlebars to enable a more upright riding position and using a different range of gears to make up for loss of leg power (**Box 11**). Some participants had converted to 3-wheeled 'trikes' to make up for a loss of balance and some were seriously considering switching to power assisted electric bikes ('e-bikes'). The issue of bikes that did not fully meet the needs of the rider or fit their bodies was compounded further for women. Many spoke about the fact that they often put up with uncomfortable bikes that had been chosen for them or were ill-advised by a cycle retailer. In some cases the difficult riding position left them feeling vulnerable and not fully in control.

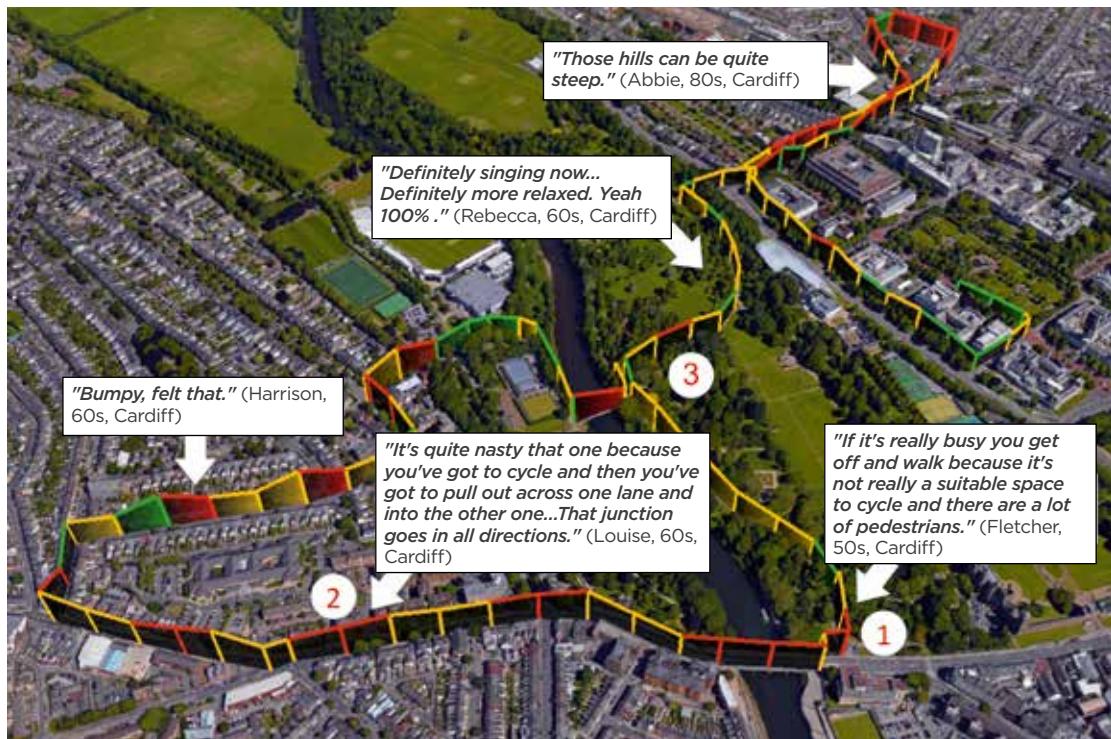
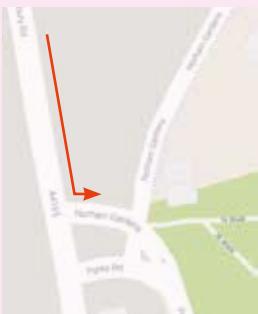


Figure 22. Map of aggregated GSR data for Cardiff participants
(Map data ©2015 Google)

BOX 9 Lindsey's left-turn

"If the pavement is clear and it looks safer to me I will be on the pavement, but always keeping a beady eye out for pedestrians, I give way to pedestrians".
 (Lindsey, 70s, Oxford).



Map data ©2015 Google

LINDSEY APPROACHES SIGNALISED JUNCTION TO MAKE LEFT TURN.

1



I actually think it is SAFER to get round that corner before this lot [queuing traffic] especially if there are buses there..

SCOOTS PAST STATIONARY CYCLIST.

2



I stopped a bit, thought about it, and then thought, 'oh my God, this is going to take ages because they are very slow these lights.'

... 'JUMPS' RED LIGHT AND RIDES UP DROPPED KERB ONTO PAVEMENT.

3



So I whipped up there onto the pavement...

NAVIGATES PAVEMENT WITH CAUTION...

4


...AND RE-JOINS THE ROAD.

5



I can see that that would probably get me a black mark from the Police but it didn't feel too bad to me.

LINDSEY REFLECTS ON THE DESIGN OF THE JUNCTION...

6



It is a shame they couldn't have put a left-turn bicycle path, that would have sloped round a bit of the pavement there, because then they could have put in a left turn for bi-cycles even if not for four wheeled traffic.

...AND DESCRIBES HER FEELINGS AFTER SAFELY NEGOTIATING THE JUNCTION & REACHING THE CYCLE TRACK.

7



...and then we are into safety, I have a sigh of relief when I get to that point... [you have] to be hyper-vigilant..

BOX 10

"I find looking over my right shoulder more problematic. It's about flexibility actually, I suppose you get on and you get less [flexible]. I use my peripheral vision and also [you are] using your hearing... These days you aren't hearing quite as much cars and much less 'rattlely' noises." (Eduardo, 50s, Cardiff).

"I don't like looking over my shoulder, partly as a result of the accident I had in the car, lost some mobility turning right, if I was turning right I tend to stop, look around and then cut across, particularly if I am tired and it is up hill..." (Gareth, 60s, Bristol).

"It is really hard as you get older to get going again. It really is, so I would always try and find a way of keeping going which is exactly what I did there. I was lucky with the [traffic] lights...I will always try and keep momentum... My fitness has gone down, it really has. I'm on these [tablets], I'm not sure what it actually is, and my blood pressure is very low... Certainly, I do not want to stop. It's really quite physically hard." (Regan, 70s, Cardiff).

BOX 11

"...over the last couple of years my bike has been modified a lot, you know, it's...to cope with me as much as anything, I was getting pins and needles, I've got carpal tunnel syndrome, and so things like the handle bars come up by riding much more sat up position than I used to, I can't ride drop handle bars anymore." (Sadie, 60s, Reading).

"Because of my height I have a [longer] stem on the bike... allows me to sit more upright when cruising along, more comfortable, if I lean forward I get trouble with my back, always been a problem." (Gareth, 60s, Bristol).

"If that [wing mirror] got knocked off I'd replace it immediately...you won't see me looking over my shoulder very often, that's because I can just look down to see what is behind." (Alfie, 60s, Bristol).

"If I'm still working at 65...gonna get me one of them electric bikes... got to be at such a decrepit stage that I can't do the ride relatively comfortably but I don't want to lose the experience of cycling for the want of lack of hip, ankle joints or whatever..." (Sean, 50s, Oxford).

Summary

Cycling has the potential to enhance wellbeing through encouraging social and physical activity and a range of positive sensory engagements with built environments and natural spaces. However, as we have demonstrated, a number of factors negatively impact on wellbeing and contribute to cycling becoming more precarious in later life. Through observation and analysis of older cycling practices we have illustrated how, what might be considered 'normal' manoeuvres and actions, become more difficult as people age. While the issues highlighted are relevant to all cyclists, they are more acutely felt in an ageing cohort as capabilities change and previously easy activities become more difficult. We argue that diminishment of cycling is not inevitable if environments and technologies consider the diverging capabilities of different users.

Cycling and Wellbeing Trial

PARTICIPANTS WHO TOOK PART in the Cycling and Wellbeing Trial wished to re-engage with cycling after a hiatus. For this group, cycling was curtailed in adulthood or had diminished in later life usually because of deterioration in health or because of safety concerns and lack of confidence riding. Before taking part in the trial participants seldom cycled, and when they did, it was more likely to be for recreation. The findings are drawn from the Diary of Cycling Experience (DoCE); focus group discussions, pre and post-trial tests assessing wellbeing and executive function, and finally, an online exit survey conducted several months after participants had completed their trial.

Motivation to Take Part

First it should be noted that we received significant interest from the public to take part in the cycling and wellbeing trial. The 89 people we selected (see **Table 4**, page 7) reported being motivated by either what they regarded as a structured programme that could support their transition (back) into cycling for personal fitness and to lose weight; for rehabilitation after an illness; to ride socially with friends, a partner or grandchildren; or a combination of reasons. Some were also keen to use a bike to support their everyday mobility and the opportunity to try an e-bike was particularly alluring.

Level of Engagement with the Trial

Participants' experience of the trial broadly followed one of three trajectories: first, those who embraced the trial and rode more than the requested three times 30 minutes per week; second, those that endured the trial and struggled to complete the requisite amount of hours because of competing interests/time pressure, family commitments, poor weather, health issues (i.e. colds and flu) and minor

interruptions such as mechanical issues and punctures; and third, participants that exited the trial (n=12) before completion because of the onset of a medical condition (n=5); because they no longer had the time to take part (n=6); or in a single case, because the participant continued to lack confidence in cycling. The two groups of pedal (n=39) and e-bike (n=38) participants that went on to complete the 8-week trial did not differ in terms of their engagement with cycling and on average cycled for a total of 3 hours per week (on average, 30 separate journeys), apart from five pedal cyclists and one e-bike participant who failed to achieve the minimum weekly cycling requirement of 90 minutes.

Experience: Benefits

The experience of both pedal and e-bike participants was overwhelmingly positive. Those using e-bikes reported the sheer enjoyment and thrill of e-biking and how this allowed them to cope with physical ailments that made ordinary pedal cycling challenging. E-bike participants also reported feeling safer riding an e-bike compared to an ordinary pedal cycle because it allowed them to move away from junctions more quickly and to avoid wobbling up hills and inclines. The e-bike also allowed riders to cover more distance in less time but both pedal cyclists and e-bikers enjoyed the freedom to discover new routes in their local area and beyond. They also appreciated the ability to engage more intimately with the landscape and to do so in the company of others. The e-bike was seen as particularly beneficial in providing opportunities to ride with a more agile partner or friend.

The main use of pedal cycles and e-bikes was for recreation in green space away from traffic or on quiet roads, but some participants used, or started to use, their (e-)

bike to perform errands and to travel along more challenging routes to work (often pre-planned and shadowed by friend/partner). Some forfeited using the car and found cycling more versatile than public transport. There was a sense among both e-bikers and pedal cyclists that they were getting healthy exercise outdoors and a feeling that (e-)cycling was contributing to personal health and wellbeing. This included weight loss, increase in fitness, improved leg strength and endurance, better sleep and improved self-esteem. We also found, to our surprise, that a proportion of e-bike participants opted to forgo power assistance (around 15% of the total time) and this made overall physical exertion equivalent to their pedal cycle counterparts. Having engaged in the study, there was a palpable sense of achievement and satisfaction in written narratives from both pedal and e-bike groups. Participants commented that the initial cycle assessment/training programme had helped them gain confidence and they also felt that the 8-week 'structured programme' had motivated them to keep going and gain confidence and also be more appreciative of cyclists' needs when driving.

Experience: Challenges

The challenges of cycling for both pedal and e-bike participants – in addition to the common theme of the challenges of cycling in unpredictable British weather which detracted from an otherwise positive experience – were mainly related to the poor quality of infrastructure. This was commonly articulated with respect to familiar environs in the local neighbourhood, but also with regard to newly discovered routes, particularly along busy main roads and in urban centres. Purpose built cycle infrastructure was generally regarded as narrow, inconsistent and poorly maintained. This coupled with the common feeling of hazards (e.g. potholes) and danger when cycling on the road meant that routes were carefully planned to avoid traffic and kept to certain domains such as quiet residential streets and paths through green spaces and along waterways. Often participants recounted using pavements where they felt threatened

by traffic and were keen to point out that they did so with regard to pedestrians. But even on purpose-built shared pedestrian and cycle paths away from motor traffic participants recounted difficulties knowing where they should cycle and that this led to problems interacting with pedestrians because of poor legibility. Other issues included difficulty negotiating barriers and gates along paths separated from traffic that required them to stop and dismount and therefore hindered smooth riding. Many comments were also made about difficulties storing bicycles at home and the lack of convenient access from the front gate. This extended to cycle parking areas in public places and parking areas particularly in town centres and transport hubs as well as gates, steps and bridges that were sometimes encountered along journeys – the additional weight of e-bikes compounded these issues. There was also concern about leaving cycles, and particularly more expensive e-bikes, in public places because of fear of theft.

There were some minor issues in relation to operating e-bikes such as difficulty removing keys from integrated locks and the battery housing. There were cases of participants forgetting to charge the battery and some instances of it running out of charge forcing them to pedal home unassisted. Some participants were surprised and frustrated with the paraphernalia required to perform cycling (e.g. gloves, helmets, locks, hi-vis items, panniers). This was particularly the case when participants attempted errands to local shops where constantly removing and re-attaching equipment became a hindrance. E-bike participants wrote about how the e-bike had become a talking point with strangers who had shown an interest but how there were misperceptions about its operation with many assuming that you did not need to pedal and therefore it was somehow 'cheating'. The power assistance distinguished the experience of e-bike users from their pedal counterparts. Pedal cyclists were more likely to express feelings of tiredness and lack of energy to cycle and some expressed regret that they had not been selected for the e-bike trial.

Cycling and Wellbeing Vignettes

A series of short video vignettes were produced with 12 participants from the trial. These were selected as they exemplify many of the key themes highlighted and all agreed for their videos (and identity) to be made public.



Watch Mike tell his story

[www.cycleboom.org/video/
mike-ball/](http://www.cycleboom.org/video/mike-ball/)

*Themes: Exercise, Fitness,
Mobility, Enjoyment, Trial
structure, Topography,
Infrastructure, Weather*

describes Abingdon's suitability for cycling and how the trial provided a programme to motivate him to get back on a bike. Mike explains how getting married and having a hip operation since the trial have hindered his cycling but that he needs more exercise to lose weight, preferring using a bike to 'being a gym bunny'.

Mike Ball, 60s, Abingdon near Oxford, Pedal cycle trial

Mike was a retired management consultant who, at the time of the trial, was living alone in a detached house in a suburb in north Abingdon. His sons had left home and his first wife had died in 2009.

Mike grew up in suburban Nottingham. His first, and main, phase of cycling was riding bikes as a child and then as a student in Cambridge. On finishing university he got married, got his first job, moved to Oxfordshire, bought a car and left his bike in Cambridge. His two sons were born in the mid-70s. After moving to Abingdon Mike only cycled occasionally, borrowing his sons' bikes when they were older. He had one further phase of cycling in the mid-2000s when he had knee problems and borrowed his son's bike for exercise. Once his knee had improved he continued running and playing squash.

Before taking part in the cycling and wellbeing trial Mike did not own a bike and had not cycled at all for around 10 years. He had been diagnosed with arthritis in his hip 3 years previously and a course of cortisone injections had made physical activity less painful.

In this film Mike explains his motivation for getting involved in the trial in terms of having a bike to try out, maintaining levels of physical exercise after giving up running and replacing local car journeys. He

cycling and how the trial provided a programme to motivate him to get back on a bike. Mike explains how getting married and having a hip operation since the trial have hindered his cycling but that he needs more exercise to lose weight, preferring using a bike to 'being a gym bunny'.



Watch Erica tell her story

[http://www.cycleboom.org/
video/erica-willis/](http://www.cycleboom.org/video/erica-willis/)

*Themes: Fitness, Mobility,
Sociability, Topography,
Exercise*

Erica Willis, 60s, village outside Oxford, Pedal cycle trial

Erica lived in Eynsham, a large village 7 miles to the North West of Oxford. She had recently retired from teaching reception-aged children and had lived alone since her husband died in 2012. Growing up in NW London Erica had cycled extensively until she had to travel further to school and then had to leave home to live in locations she found unsuitable for cycling. This changed when moving to Eynsham which was fairly flat, small and other cyclists were visible. She purchased a 'basic bike' and rear seat to transport her daughters and they cycled locally as a family as well as some occasional commuting to her part time jobs. This increased when she started teaching full time in nearby Witney whereupon she bought a new bike as part of a plan to get fit. Erica was diagnosed with breast cancer in 2011. She had done occasional, very local, cycling for fitness since she started her treatment for cancer and preferred cycling to driving.

In this film Erica explains how having the structure of the cycle BOOM trial helped her to re-engage with using her bike and the many benefits she gained including increased fitness, less back pain, ease of shopping locally, connecting to nature and people, losing weight, sleeping better and how cycling in the outdoors was preferable to the gym.



Watch Jon tell his story

www.cycleboom.org/video/jon-cameron/

Themes: Exercise, Image, Enjoyment, Weather, Traffic, Infrastructure, Cost

Jon Cameron, 60s, village near Oxford, E-bike trial

Jon retired in 2008 and moved to Forest Hill, a small village to the East of Oxford, in 2013 where he was rebuilding a cottage which he shared with his partner. He had cycled extensively when growing up and had been given a Raleigh bike for passing his 11+ exam which he used to go to school and also to roam with his brother and friends. Jon continued to cycle to school until it became 'uncool' and he graduated to bus, moped and then car. He had passed his driving test at 17 and driven cars ever since describing himself as a "*bit of a car freak*". The only cycling he has done since included while on holiday in the Channel Islands with his wife and with his son to teach him to ride.

Jon had developed diabetes as a result of being over-weight and had decided to retire from being an IT consultant to concentrate on his interests. He used a quad bike off-road for deer stalking; his other exercise came from walking his dogs and working on his property. Prior to the trial Jon did not own a bike or do any cycling. Jon had been advised by his doctor that he could improve his health by exercising and losing weight and thought the Wellbeing Trial was a good way of trying out cycling as exercise without any outlay.

In this film Jon explains how diabetes has affected his mobility and how he wanted to try using an e-bike for exercise, testing Oxford's reputation as a cycle friendly city. He reflects on the enjoyment he got from using the e-bike, the benefits of the steady exercise but how vulnerable he felt riding at times and the poor state of cycling infrastructure. He also describes the challenge of weather, his problems with operating the e-bike and his surprise at their initial cost.



Watch Brian tell his story

www.cycleboom.org/video/brian-hook/

Themes: Sociability, Enjoyment, Fitness, Exploration, Wellbeing, Mobility

Brian Hook, 80s, Abingdon near Oxford, E-bike trial

Brian took part in the e-bike trial and his partner Gill also bought an e-bike to share the experience with him. They have lived together in Abingdon since 2012. Brian was born and grew up in Oxford and cycled extensively when younger for transport and sport. He worked for Oxfordshire County Council as a buildings officer, mostly commuting by bike until retiring in 1990. Since then Brian had cycled locally on shopping trips and he and Gill had done a variety of regular local rides together for pleasure and for transport, often travelling up to 24 miles, mainly on cycle paths. They also took their bikes by car or train to more distant UK locations on holidays. They are generally very active, swimming and playing ball games.

Brian's cycling had been curtailed more recently by time constraints of playing sport, a busy family life and a knee problem which made cycling painful, slowing him down.

In this film Brian describes how the e-bike made cycling enjoyable again. He found it comfortable and "*thrillingly fast to ride*", without suffering any knee pain and still getting useful exercise. Brian explains

how the e-bike replaced short car journeys and how he and Gill ventured further afield together, revisiting old haunts and discovering new places, safe in the knowledge that the battery can help him return home from longer trips if tired. Brian and Gill describe how this cycling together was much more enjoyable than walking. Gill also reflects on the significant positive impact on Brian's overall wellbeing of re-engaging with cycling.



Watch Gill tell her story
[www.cycleboom.org/video/
gill-flynn/](http://www.cycleboom.org/video/gill-flynn/)

Themes: *Freedom, Independence, Sociability, Fitness, Weight, Wellbeing, Image*

Gill Flynn, 60s, Oxford, Pedal cycle trial

Gill purchased a new bike to enable her to take part in the pedal cycle trial. She had lived on her own in Barton, on the Eastern edge of Oxford for 11 years, doing very little cycling during this time. Gill had grown up in East Oxford and had used a bike extensively during her 20s doing postal deliveries and for transport. She had cycled with her second child when he was younger and used a bike for social visits until moving closer to her family. Suffering from agoraphobia, Gill hadn't used public transport for many years and had relied on taxis for the last decade. After a serious health issue within the last two years Gill had been using a static bike to build up her muscle strength again and was now doing voluntary work at a local health and wellbeing centre. Gill smoked and her exercise was mainly from doing housework and walking locally.

In this film Gill talks about re-discovering the joys of cycling, how being on a 'real' bike was much better than an exercise bike indoors as she can see her surroundings, experience a sense of freedom and independence, visit friends as well as getting fitter and losing weight. She explains how her new bike is both a 'fashion accessory and friend', with people asking to photograph her in the street with her bike.



Watch Deborah tell her story

[www.cycleboom.org/video/
deborah-ajulu/](http://www.cycleboom.org/video/deborah-ajulu/)

Themes: *: Fitness, Weight, Weather, Training, Safety, Mobility*

Deborah Ajulu, 60s, Oxford, E-bike Trial

Deborah lived on her own in a sheltered accommodation flat in south east Oxford where she had lived since arriving as a refugee from Uganda in 1987. After retiring from an academic career she continued to work voluntarily for a charity implementing community development projects in Eastern Uganda.

Deborah learned to ride a bike as a teenager in rural Africa but after moving to Kampala she no longer had access to a bike and used taxis for getting around the city. Deborah gained access to a car when she got married but then left Uganda with her children and separated from her husband. When she arrived in the UK having three children to transport meant having a car was important to her.

Deborah cycled again in her early fifties when she went back to Uganda to work and was given a bicycle but she only used this two or three times a year to make short journeys. After returning to Oxford in 2011, she no longer had a car. Instead, she bought a bike to enable her to move around more quickly than walking or using public transport, and at the same time, gain some exercise. She was not very confident cycling on the roads and frequently used the pavement but

did not feel comfortable doing so. Deborah's cycling stopped one winter whereupon she deposited her bike in the communal store where it fell into disrepair. Deborah was attracted to participate in the cycle Boom trial to improve her health and lose weight.

In this film Deborah explains how she was motivated to join the trial partly by the offer of cycle training. She describes her initial lack of knowledge about e-bikes and was uncertain whether she would be able to ride it. Deborah contrasts her e-bike experience with pedal cycles in terms of the additional skills needed to operate it as well as the problems manoeuvring it because of the extra weight of the battery. She describes the difficulty she had during the trial trying to ride in the rain while wearing spectacles and also an incident where she fell off causing minor injury. Deborah reflects on how, despite this, the e-bike improved her local mobility and was particularly advantageous in helping her to tackle hills.



Watch Val tell her story

[www.cycleboom.org/video/
val-scatchard/](http://www.cycleboom.org/video/val-scatchard/)

Themes: Fitness, Weight, Training, Traffic, Topography, Safety, Weather, Mobility

Val Scatchard, 60s, Oxford, E-bike trial

Val was a retired nurse living in Cumnor, on the western outskirts of Oxford with her husband. They had moved there four years ago and were in the process of renovating properties to enable their two sons and their families to live with them.

Growing up in SW London, Val used her bike to "go everywhere", cycling to secondary school daily. But as a teenager she stopped cycling as it was no longer seen as 'cool'. She didn't use a bike during her time as a student but bought a car for commuting when she started her job as a nurse. Having two children, then travelling overland to live in New Zealand and having a preference for walking as a main leisure activity meant cycling was largely absent from her life. Returning to live in Oxfordshire in 1984 Val and her husband bought hybrid bikes which she used locally with their children and did limited commuting. Val had health issues which limited her activities in the last few years including a shoulder injury and surgery on her feet. These were now resolved but had meant she had put on weight and wasn't as physically fit as she would have liked. After the death of her parents, who she had been caring for, she had more time available for cycling.

In this film Val describes the positive impact that the cycle training she received had on her confidence. She also recounts how she found riding an e-bike safer, more flexible for things like shopping in central Oxford as well as being a great help tackling a major hill on her journey home - this had left her feeling "*spoiled*" in comparison with using her pedal cycle.



Watch Dave tell his story

[www.cycleboom.org/video/
dave-thurston/](http://www.cycleboom.org/video/dave-thurston/)

Themes: Exercise, Fitness, Mobility, Enjoyment, Traffic, Infrastructure

Dave Thurston, 50s, Reading, E-bike trial

Dave lived in a quiet cul-de-sac in Reading with his wife and eldest son. He was recovering from a second heart attack twelve months previously and suffered from fatigue. He had cycled all his life until he became unwell in 2002 and was keen to see if cycling could improve his stamina and fitness. He was currently walking daily and volunteered at a cardio gym but did not own a bike.

Growing up, Dave's parents didn't have a car and so they travelled by bike or moped. He learnt to ride a bike in the Close where he now lives and used a bike a great deal with friends, cycling to local weekly activities and as far as the 45 minutes to Pangbourne. When he and his wife got a car in the 1980s, it was mainly for his wife to go shopping and pick up the children from school. He still used his bike as his main mode of transport until he worked for courier companies too far away to cycle to.

In this film Dave recounts his reasons for getting involved in the study - wanting to improve his fitness and widen his horizons. He reflects on how the benefits of the e-bike, including riding position, journey speed and reliability and confidence getting home led him to buy one after

the trial. He relates how peak traffic is a challenge but how he avoids this by changing his time of travel or the route that he uses. Finally he details his plans for expanding his e-biking in the future.



Watch Jo tell her story

[www.cycleboom.org/video/
jo-baldock/](http://www.cycleboom.org/video/jo-baldock/)

*Themes: Exercise, Enjoyment,
Weight, Wellbeing,
Infrastructure, Traffic*

better, improving her balance, enjoying exercise, helping her switch off and feeling more relaxed. Negative aspects for Jo were the dangers of traffic and poor maintenance of cycle tracks but these didn't stop her buying her own e-bike at the end of the trial. She explains the rationale for her choice and goes on to extol the virtues of e-biking for older people.

Terry Clarke, 80s, Reading, Pedal cycle trial



Watch Terry tell his story

[www.cycleboom.org/video/
terry-clarke/](http://www.cycleboom.org/video/terry-clarke/)

*Themes: Exercise, Enjoyment,
Sociability, Topography, Traffic,
Mobility*

In this film Terry describes how cycling during the trial provided useful exercise, in addition to walking and golf. He reflects on an enjoyable ride along the river with one of his sons, and the challenge of the steep hill on their return. Terry was also wary of cycling in traffic. He explains how he felt the need to wear a helmet and fluorescent gear, and kept mainly to local, quiet, residential streets. Terry tells how he has done little cycling since the trial as he gets sufficient exercise and finds the car convenient but concludes that it makes him lazy.



Watch Michael tell his story

[www.cycleboom.org/video/
michael-quirke/](http://www.cycleboom.org/video/michael-quirke/)

Themes: *Fitness, Mobility,
Sociability, Topography,
Exercise*

Michael Quirke, Oxford, E-bike trial

Michael had retired in 1998 and had lived with his wife in a bungalow on a quiet cul-de-sac in East Oxford since 1988. Growing up in Ireland he had cycled very extensively with his friends, eventually selling his bike to cover his travel to a job in Southampton aged 19. He then moved to a series of workplaces around the UK, ending up in Oxford in 1955. Here he cycled to work at the Morris Motors Car Factory where he was a construction worker. Following this he travelled by car from Oxford to work all over the UK but cycled at the weekend whenever he could. His son and daughter had both learned to ride and he still cycled with his daughter. Michael got a new bike on retirement and used this for regular trips around the ring road for exercise. His wife had become ill in 2012 and he had been caring for her. This had meant that he had had a break from cycling for two years before recently starting to use his pedal cycle again for leisure and shopping rides. He had found this difficult due to traffic, hills, sore knees and his legs 'giving out'.

In this film Michael describes how the e-bike was 'the best thing since chewing gum'. It had encouraged him to ride more regularly with his daughter, enabled him to extend his cycling and to tackle significant hills in the city.



Watch Nicola and Clive tell their story

[http://www.cycleboom.org/
video/nicola-clive-tipler/](http://www.cycleboom.org/video/nicola-clive-tipler/)

Themes: *Wellbeing, Traffic,
Enjoyment, Mobility,
Infrastructure*

Nicola and Clive Tipler, 60s, Reading, Pedal cycle trial

Nicola and Clive lived close to the centre of Reading. Nicola was a retired science teacher and Clive was a retired technical engineer. They both had adult children from previous marriages.

As a child, Nicola cycled a lot where she grew up in SW London. There was little traffic and she felt safe on the roads. However, once she left home, she did not have the opportunity to cycle again for the next fifteen years. After returning to live in the UK after a period of living abroad, and having also separated from her husband, she started using a bike for transport to work and for shopping. She did not own a car for two years. She discovered 'Bicycle Beano' cycling holidays in Wales and Shropshire, which she loved, and has continued to take for the last thirty years.

Clive grew up in Berkshire and cycled as a child but after leaving school he started using scooters and cars. When first married he lived in Wokingham, and felt proud to be the only person, locally, who cycled to work. He found it quicker and cheaper than driving. However, his cycling stopped after moving to Windsor, working shifts at Heathrow and spending many years caring for his first wife. He re-engaged with cycling from 2003, after meeting Nicola, and went to a lot of effort to buy himself a comfortable bike for the long, hilly rides in Wales.

Before the trial, Clive and Nicola were cycling most weeks for leisure, when the weather was fine, but without consistency or a regular pattern. They both have hybrid bikes and folding Bromptons, which they have taken on trains for cycling in Yorkshire and France. Nicola felt she wasn't able to do enough local cycling, because of anxiety about safety on the roads. She tended to walk, drive or use the bus.

In this film, Nicola and Clive talk about their reasons for getting involved in the wellbeing trial, and contrast their experience of cycling in central Reading with more rural areas. Clive recounts how cycling, even in the rain, stops him being a "grumpy old man". Nicola also emphasises the feel good factor she gets from cycling and reflects on how this could be increased in Reading, wanting an experience more like her leisure rides and informed by her cycling in Holland and Sweden.

Cognitive Processes and Wellbeing

Our results indicated that cycling may improve spatial reasoning, executive function and mental health. However, we did not detect any significant change in memory or attention scores when comparing pre and post-trial test results for either e-bike or pedal cycle groups.

Spatial Reasoning

E-bike and pedal groups made fewer errors and demonstrated faster reaction times compared to before the trial. This was particularly the case for e-bike participants when undertaking the mental rotation task (see page 11) and for pedal cyclists tasked with drawing a route out of a maze as quickly as possible. This suggests that both physical exercise (for the pedal cyclists) and engaging with outdoor environments (for the pedal and e-bike participants) can improve spatial reasoning.

Executive Function

Post trial tests of executive function for both e-bike and pedal cycle groups showed improved performance compared to pre-trial. Significant change in performance was observed for verbal fluency (the ability to update information in working memory) and the letter updating task, which measures updating ability by asking participants to remember the last 3 letters of a sequence with a letter continually being added to the sequence – see example of letter updating task on page 11. When holding the amount of time spent cycling each week constant, both e-bike and pedal cycle groups demonstrated an increase in their verbal fluency score (**Figure 23**) compared to the control group. For the letter updating task, there was improvement for both groups, but pedal cyclists demonstrated the biggest improvement (**Figure 24**).

Wellbeing

As reported earlier, many positive benefits to wellbeing were reported by participants in the Diary of Cycling Experience (DoCE). This included stimulation, weight loss, better sleep, improved eating habits and sense of freedom and independence because of increased mobility.

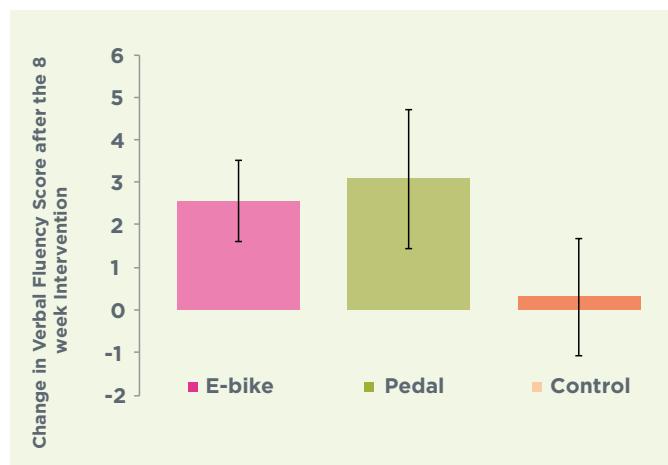


Figure 23. Change in verbal fluency score after the cycling trial - A positive score indicates better performance

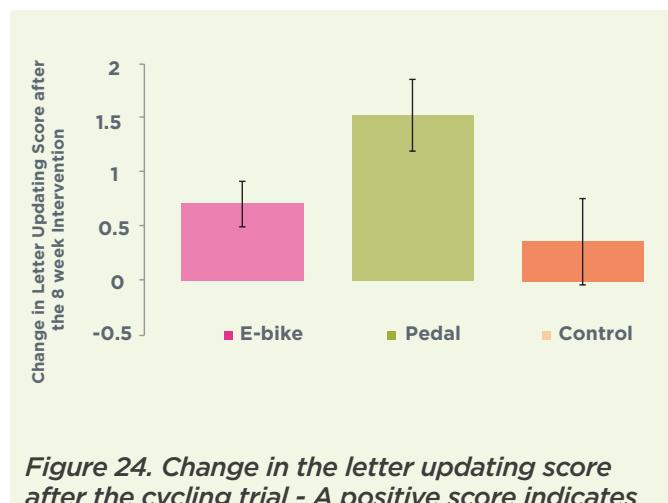


Figure 24. Change in the letter updating score after the cycling trial - A positive score indicates better performance

The questionnaire measuring psychological wellbeing (Ryff & Keyes, 1995) detected a slight increase in overall wellbeing after the trial compared to before the trial. The questionnaire measuring mental health (SF36; Ware & Sherbourne, 1992) showed a marked improvement and was stronger for e-bike than pedal cycle participants (**Figure 25**). There was also a slight improvement in positive affect (PANAS; Watson et al., 1988) for cyclists after the trial. For the e-bike group, in particular, there was a decrease in negative affect suggesting that e-biking may improve emotional wellbeing. Finally, there was a perceived improvement to physical health (SF36; Ware & Sherbourne, 1992) particularly for the e-bike group.

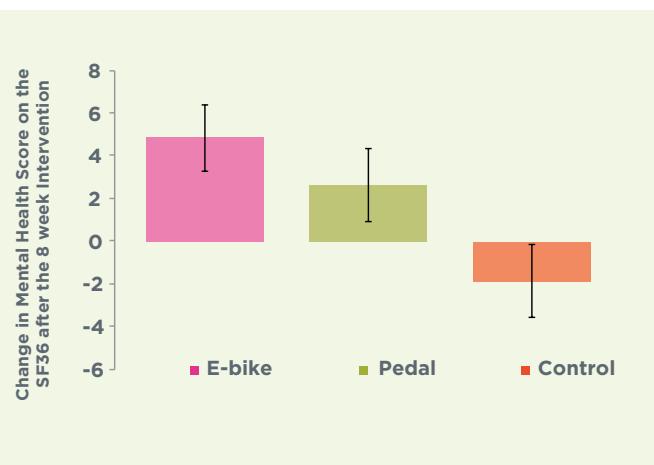


Figure 25. Change in mental health (SF36) score after the cycling intervention for all participant groups - A positive score indicates better performance (Source: Ware & Sherbourne, 1992)

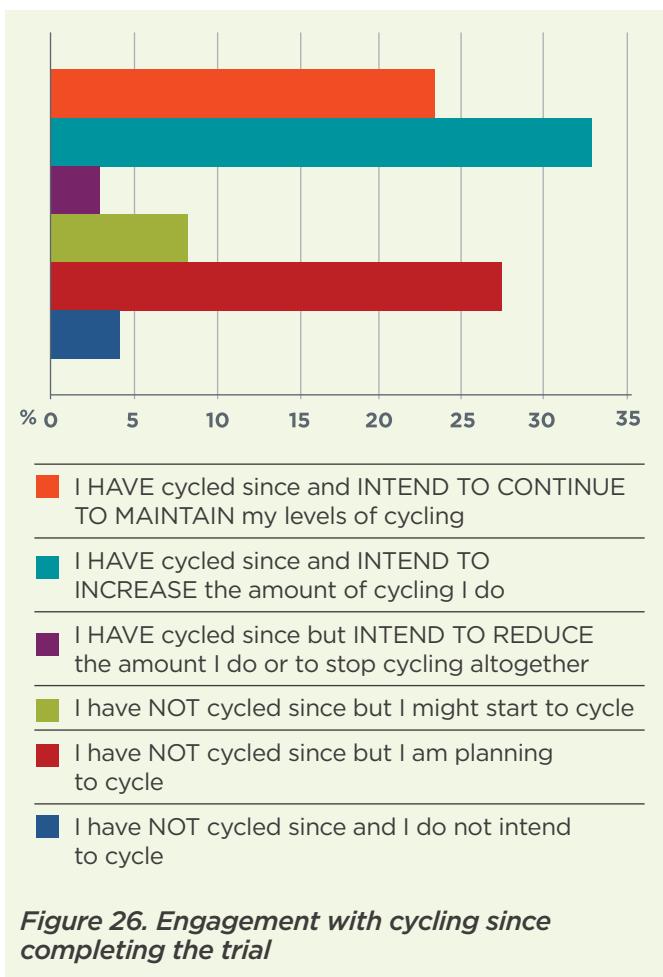


Figure 26. Engagement with cycling since completing the trial

Participant Exit Survey

Participants rated their experience of taking part in the Cycling and Wellbeing Trial and the impact this had on their personal wellbeing. The average rating on a scale from zero to ten (with ten being the highest rating) was 8.9 (SD 1.36). Over two-thirds thought that their wellbeing had improved a little or a lot compared to before they took part in the trial and that they had become more physically active.

Since completing the trial 58 per cent reported that they had cycled and intended to increase or maintain their level of cycling (**Figure 26**). A further 27 per cent reported that they had stopped but were actively planning to start cycling. Over half of all participants reported purchasing cycle related clothing, accessories and equipment, 19 went on to purchase an e-bike and a further 12 purchased a pedal cycle. It was difficult to gauge change in travel behaviour but the data (and accounts from diaries) seemed to suggest that cycling had begun to replace at least some journeys that would have otherwise been made by car.

Summary

This aspect of the cycle BOOM study has demonstrated how cycle training, together with an 8-week programme for older people keen to re-engage with cycling, can have a positive effect on cognitive processes and wellbeing and also perceived physical health. This may not be simply to do with increased physical exercise (and therefore increased cerebral blood flow) but also the opportunity cycling provides for older people to engage with the outdoor environment.

Summary and Key Messages

'Because active ageing is a lifelong process, an age-friendly city is not just "elderly-friendly". Barrier-free buildings and streets enhance the mobility and independence of people with disabilities, young as well as old.' *WHO (2007) Global Age-friendly Cities : A Guide*

THIS RESEARCH HAS HIGHLIGHTED three groups of potential and existing older riders. **Reluctant riders** form a majority of the older population. The possibility of them cycling for everyday mobility is low. At best, cycling is likely to take place in areas away from traffic in fine weather for recreation, for example, while on holiday. **Resilient Riders**, on the other hand, represent only a small proportion of the UK population. They have what can be described as a positive antecedent state towards cycling. They enjoy the convenience of cycling and recognise the health and environmental benefits. They tend to be physically active in other areas of their lives and place importance on staying active and engaged with social activities. The majority also have access to a car at their household. However, they are under no illusion that conditions for cycling are ideal and recognise that cycling today is fraught with challenges - often discussing the 'halcyon days' when there was less motor traffic. Although they have *acclimatised* to changes over time they have had to adapt their style of riding to deal with changing conditions and capability. Many also questioned if they would be able to re-engage with cycling nowadays if they hadn't acclimatised over time.

These adaptations include exercising discretion on **timing of travel**, for example, when the weather is fine, during daylight hours and outside of busy periods, and **route choice**, avoiding busy roads and hills (or dismounting and wheeling bicycle) and taking backstreets and off-road paths through green space. Pavement cycling is also common in situations where cycling on the road is regarded as unsafe but emphasis is placed on performing these **civil transgressions** in a respectable manner with regard to pedestrians and other space users. Because of the perceived vulnerability in traffic, '**diligence**' and '**deferen^{ce}**' is exercised and represented through heightened concentration and avoidance of situations where personal safety could be compromised or there is a chance of

getting caught up in a contagion of aggression. Examples include, dismounting on inclines for fear of wobbling and 'getting in the way of traffic'; pulling over to the left and performing staged right-turns because of difficulty looking over shoulder and merging into the centre of the road. Further adaptations are to **bicycles and equipment** through the addition of accessories that improve safety and security (e.g. reflective gear, lights, bells, locks) and that provide more comfort (e.g. comfort 'gel' saddles, baskets/panniers, handlebar mirrors). This situation suggests cycling is highly precarious. **Resilient riders** represent a '**cycling Precariat**'; although many expressed a desire to continue to cycle as long as possible they are under no illusions as to the difficulties they would face as they became older and less agile in a system largely unsupportive of their needs. This will require significant measures to ensure that cycling is prolonged among this group, let alone encourage reluctant riders to engage with cycling.

This research also engaged with people who represent a potentially significant market who are interested in (re)engaging with cycling. **Re-engaged Riders** place importance on staying active and engaged with social activities and cycling is regarded as a preferable option among others in pursuit of an active ageing project. Many among this group have time and (in many cases) income to devote to cycling. The experience of those we interviewed who had re-engaged in the last five years demonstrated that they had found spatial domains to cycle (typically traffic-free or with light traffic) but had not developed confidence to cycle in a full range of environments. The cycling and wellbeing trial demonstrated their positive experience of cycling especially in circumstances where they felt they had control of their cycling activity i.e. when, where, how and with whom it took place. This was usually when riding in leisure spaces but also for utility journeys away from busy streets and motor traffic. However, their cycling is even

more precarious than already acclimatised resilient riders because they have to relearn and reconnect with cycling after a hiatus under quite different conditions.

In summary, the key message that emerges from this study is that cycling is regarded as **dangerous** and the majority of the older population is therefore reluctant to cycle. Cycling also often becomes more **difficult** for people as they get older because of an ageing body, unsupportive built environment and technology ill adapted to their needs. In short, to perform everyday cycling mobility often requires tremendous physical and emotional labour and therefore a willingness and ability to develop resilience. Despite this, cycling remains **desirable** among a smaller but significant minority of older people who have or are managing to prolong cycling under specific circumstances of their choosing – what we might term ‘partial cycling’. There is also the potential to engage a significant market of retired people contemplating cycling as part of a personal project for healthy ageing particularly given the growth in the availability and popularity of power-assisted cycles (e-bikes).

A substantial shift in culture towards planning for older mobility is required if cycling is to be embedded in the lives of an increasingly older population. This will require a substantial shift in approach and policy across different sectors and partnership working at all levels in order to realise this ambition. This report concludes with a series of recommendations towards age-friendly cycling mobility.

Key messages are as follows:

- 1.** Older people are not one homogenous group. This should be recognized when planning programmes to support older mobility. There is a need to challenge age stereotypes and portrayal of decline and dependency and instead portray a positive image of active ageing.
- 2.** Older cycling is partial and resigned to specific times and spaces because of poor and largely unsupportive infrastructure for everyday cycling. This raises questions about spatial justice and of the need to engage older people in participatory approaches to designing public space for cycling at an early stage. Improvements that enable cycling by older people have broader benefits for pedestrians, drivers and other cyclists of different ages and abilities.
- 3.** Cycling offers the potential for positive experience by providing older people with the means to participate in meaningful activity: to engage with landscape, foster personal relationships and maintain social contact with the outside world. The broader health and wellbeing benefits of cycling need to be recognized, promoted and supported through activities, events and programmes.
- 4.** An ageing body throws up new challenges for cycling but new and rapidly evolving cycling technologies have the potential to promote and prolong cycling among the older population and make cycling enjoyable. Power assisted cycles ('e-bikes') and other technological innovations should be developed, promoted and supported as part of the health and sustainable mobility agenda.
- 5.** Older cycling is precarious - a whole generation that has already acquired cycling skills is diminishing. Policies and programmes are required across sectors that involve multiple actors working together to deliver a broader age friendly cycling agenda as part of the government's Cycling and Walking Investment Strategy. There is an urgent need to act now to develop the infrastructure fit for an ageing society.
- 6.** The issue of unsupportive infrastructure and road danger for older cyclists is also relevant to children and young people. And while maintaining health is an issue for the older population, there is a prevalence of low levels of fitness and high levels of obesity among young people. Interventions targeted at promoting older cycling would, therefore, also support younger cycling and help to address these pressing social issues.

Recommendations: Towards Age-friendly Cycling Mobility

'It should be normal in an age-friendly city for the natural and built environment to anticipate users with different capacities instead of designing for the mythical "average" (i.e. young) person. An age friendly city emphasizes "enablement" rather than "disablement". It is friendly for all ages and not just "elder friendly".' *WHO (2007; p72) Global Age Friendly Cities*

THE GLOBAL AGE-FRIENDLY CITIES project by the World Health Organisation calls for understanding and attention to the needs of those most vulnerable people in society (i.e. older adults and children) in order to increase the number of people who become or remain physically active. The Global Age Friendly Cities guide (WHO, 2007) recognises the important role of cycling (and walking) in achieving this. The document has informed many initiatives across the global age-friendly network of over 200 cities and communities. In the UK, 12 cities established the UK Network of Age Friendly Cities. This network has the potential to help shape city cycling strategies and place emphasis on normalising cycling and providing supportive 'intergenerational space', that is, spatial arrangements that facilitate positive encounters between different age groups (Jones & Spencer, 2016). Paralleling this has been the rise of advocacy groups such as 8-80 Cities that is dedicated to 'transforming cities into places where all people can walk, bike, access public transit and visit vibrant parks, streets and other public places' (see www.880cities.org). This Canadian based non-profit organisation has flourished and its impact in shaping more democratic approaches to cycling provision has been far reaching, for example, in cities such as Seville in Spain.



Scan to view the cycle BOOM video highlighting how emerging cycling cities of Seville (ES) and Munich (DE) have managed to promote more diverse and older cycling. Or visit: www.cycleboom.org/key-findings-videos/

The age friendly cities agenda provides the opportunity to support and promote cycling (and walking). Our recommendations are organised under the World Health Organisation's Age-Friendly domains in the Global Age-friendly Cities guide (WHO 2007) see **Figure 27**. The Age-Friendly Cities approach is based on the principle of inclusive design – that good provision for older people will have benefits for all potential cyclists, a philosophy also aligned with the 8-80 Cities movement (**Figure 28**). Here we identify specific measures towards developing age friendly cycling mobility that promotes quality of life, access and safety. This is not meant to be an exhaustive list but a foundation on which to further develop an age-friendly cycling agenda.

RECOMMENDATIONS

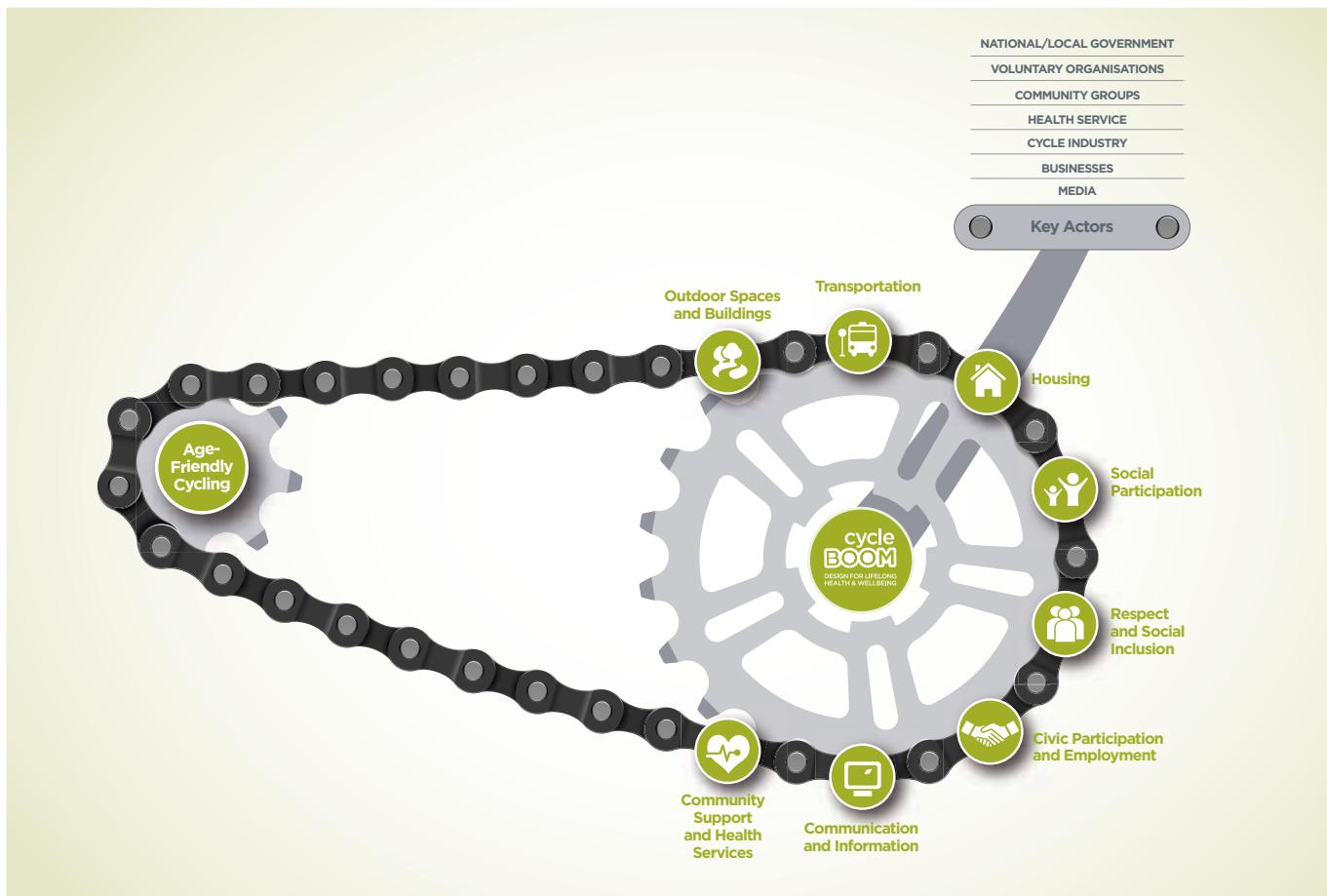


Figure 27. People powered age-friendly cycling



Figure 28. Towards infrastructure for intergenerational cycling. Hills Road, Cambridge (Photo: Ben Spencer)

Outdoor Spaces and Buildings

Outdoor space needs to offer a safe, comfortable and enjoyable experience for cycling. It should stimulate positive impact on wellbeing through social interaction and engagement with place. Space can be made more cycle-friendly through well-designed and maintained cycling infrastructure. This should enable ease of movement through urban and rural areas and allow momentum to be maintained. However, cycling is more than about efficiency in getting from A to B and so opportunities should also be provided for people to dwell and interact with the outdoors.



Figure 29. Junctions – resting rails provide support and convenience at junctions and have been implemented in Copenhagen, DK and are starting to appear in other cities such as Chicago, USA (Photo: Copenhagenize.com)



Figure 30. Separated Cycle Paths – the Netherlands uses red colour and texture on its cycle paths throughout the country so inhabitants are clear on the distinction between cycle paths and pedestrian paths. (Photo: Tim Jones)



Figure 31. Junctions – Low level signals – the Statutory Instrument Traffic Signs Regulations and General Directions now permits measures that can support older cycling (Photo: Sustrans UK)

This can be achieved by:

1. Providing dedicated cycling infrastructure separated from motor traffic and pedestrians on or close to all main roads and arterial routes into towns and cities and rural hinterlands and opportunities for side-by-side ‘social cycling’.
2. Improving junctions and crossings by implementing measures now permitted in the Statutory Instrument, Traffic Signs Regulations and General Directions (2016)¹ including low level cycle signals, early start for cyclists and parallel pedestrian and cyclist crossings.
3. Implementing low speed zones in urban and rural areas to create conditions for safer, less harried, more civilised cycling for all.
4. Improving the quality of design so that it is clear where cyclists are ‘meant to be’. This means ensuring routes are clearly signposted and consistent in surface texture and colour across the UK and that they provide a comfortable and positive sensorial experience.
5. Designing outdoor space and cycle parking to support a range of cycle types including trikes and electric-bikes.



Figure 32. Crossings – parallel cycle and pedestrian crossing, Chapel Field North, Norwich. (Photo: Sustrans, UK).

¹ <http://www.legislation.gov.uk/uksi/2016/362/contents/made>

Transportation

There is a need to recognise the full potential of cycling as mobility tool/aid for older people. Transport systems need to cater for all capabilities. Cycling should be an easy, safe and enjoyable way of moving around urban and rural areas. Seamless integration with other methods of travel including cars and public transport allows boundaries for cycling to be extended. The growing e-bike market also provides an opportunity to encourage and prolong cycling among the older population.



Figure 33. Secure cycle parking and electric charging points for e-bikes, Amsterdam (Photo: Tim Jones)



Figure 34. Public bike hire scheme, Oxford, includes electric bikes (Photo: Tim Jones)

This can be achieved by:

1. Developing a strategy to reduce motorised traffic levels, particularly heavy goods vehicles, in the centre of towns and cities to allow cycling (and walking) to flourish.
2. Ensuring that public bike schemes provide cycles that are easy to use by older riders (e.g. unisex 'step-through' frame, electric bikes) and that they can be accessed with concessionary travel cards.
3. Providing designated secure cycle parking at public transport hubs with charging points for e-bikes, step-free access and adequate width and space for non-standard bikes.
4. Working with public transport operators and motor vehicle manufacturers to find solutions for in/on vehicle carriage of cycles and charging of e-bikes.
5. Encouraging the cycle industry to design for and support lifetime cycling mobility through offering a broader range of cycles (including e-bikes) to suit older riders, improving customer service, and working with government to offer tax-free saving on the purchase of (e-)bikes.



Figure 35. Bus services can transport cycles (Photo: Nottingham City Transport)

Housing

Secure and convenient cycle storage and street access are important to ensure cycles are easy to retain and use. There is also the need to ‘think beyond the building’ to the immediate neighbourhood to gain access to services by bike.



Figure 36. Convenient ‘front-of-house’ cycle storage, Houten, NL. (Photo: Tim Jones)

This can be achieved by:

1. Siting new housing development for older people in flatter areas to facilitate cycling and ensuring that, where there are gradients, these are gentle and provide sufficient width for lateral movement.
2. Implementing recently revised Building Regulations¹ relating to accessible, adaptable dwellings based on the Lifetime Homes standard² which could support cycle users as well as those using other mobility aids such as wheelchairs and mobility scooters, for example, by enabling convenient movement between the street and the dwelling.
3. Developing private and communal cycle storage options close to property entrances (with the ability to charge e-bikes) in order to provide safe and convenient access to cycles for everyday use - see HAPPI design criteria³.
4. Providing safe and convenient access to local services by implementing slow zones/cycle streets in residential areas and linking cycle tracks to key local amenities and green space and blue corridors into the countryside.



Figure 37. Shared on-street cycle storage, London (Photo: Liese Spencer)



Figure 38. Low speed zones, Bristol (Photo: Sustrans UK)

¹ Building Regulations Part M(4) Category 2

<https://www.gov.uk/government/publications/access-to-and-use-of-buildings-approved-document-m>

² <http://www.lifetimehomes.org.uk/pages/revised-design-criteria.html>

³ http://www.housinglin.org.uk/_library/Resources/Housing/Support_materials/Other_reports_and_guidance/HAPPI_Final_Report.pdf

Social Participation

Engaging and supporting potential and existing older cyclists with cycling should be recognised as a way of providing a sense of empowerment through social networks and independence. There is a need to identify cycle-friendly locations and provide more inclusive cycling activities for older people including cycle training.



@WeAreCyclingUK B4 2day Jim hadn't cycled for over 40 years!!! Amazing to see!
#bigbikerevival #cycling



Figure 39. Re-engaging older cyclists through the Big Bike Revival (Source: @Gear_up100 on Twitter)



Figure 40. Warrington Visually Impaired Peoples' take part in Wheels for All session (Photo: Wheels for All). Wheels for All is a nationally recognised programme that embraces all children and adults with disabilities and differing needs, to engage in a quality cycling activity. By using specially adapted cycles, the activities are both physically and mentally stimulating and above all fun for everyone involved. Organised by Cycling Projects.

This can be achieved by:

1. Developing and promoting national and local programmes and events to engage older people with cycling.
2. Promoting places in the local area and beyond where older people can cycle in safety and comfort and improve their confidence and skills, for example, the National Cycle Network¹.
3. Promoting cycle training for older people through Bikeability² and developing a specific e-bike training module as part of the national training scheme.
4. Providing cycle maintenance services specifically aimed at older people to ensure cycles are kept reliable and efficient.
5. Including information about cycling in literature preparing people emotionally for retirement and as part of planned driving cessation programmes. This should highlight the potential for cycling to improve wellbeing and information on organisations able to provide support and advice. For example, see Retirement Reinvented³.



Figure 41. Over 55 cyclists enjoying a social ride in Bristol (Source: Life Cycle UK)⁴

¹ <http://www.sustrans.org.uk/ncn/map/national-cycle-network>

² <https://bikeability.org.uk/>

³ http://www.retirementreinvented.com/Articles/63563/Retirement_Reinvented/Health/Cycling.aspx

⁴ <http://www.cycleboom.org/life-cycle-uks-55s-cycling-project/>

Respect and Social inclusion

Safe, enjoyable and inclusive cycling will be enabled through developing a culture of respectful behaviour between road users. Older people's place within the family and community can also be strengthened through involvement with cycling activities.



Figure 42. Campaign for drivers to reduce speed to protect older and younger people, Groningen, NL. (Photo: Tim Jones)



Figure 43. Intergenerational cycling, Amsterdam, NL (Photo: Ben Spencer)

This can be achieved by:

1. Promoting positive and inclusive cycling by including more images of older (and female) cyclists and intergenerational activity (e.g. cycling with grandchildren) in campaigns to promote cycling.
2. Encouraging law enforcement agencies to understand why older people occasionally ride on the pavement and to exercise their powers in dealing with pavement cycling with discretion.
3. Increasing driver awareness of the needs and vulnerabilities of older cyclists and extend driver training through the DVLA, Freight Transport Association and public service vehicle operators. See Fleet Operator Recognition Scheme¹.
4. Using participatory approaches to designing public space for cycling that includes older and less experienced cyclists and people with different cycling mobility needs.



Figure 44. Signage to encourage mutual respect, Cambridge (Photo: Ben Spencer)



Figure 45. Residents in Torquay participate in street design (Photo: Sustrans UK)

¹ <https://www.fors-online.org.uk/cms/training/online-driver-training/cycle-safety/>

Civic Participation and Employment

Cycling can be a conduit for engaging older people in meaningful activities and employment and to contribute to their community. Steps could be taken to accommodate older workers and volunteers in cycling related activity.



Figure 46. Sustrans volunteer Don in Dunstable is a ranger on the National Cycle Network and leads rides. Sustrans have 2,500 volunteer Rangers looking after the National Cycle Network. They cut back vegetation, pick up litter, check for potholes and maintain signs along the route (Photo: Sustrans UK)

This can be achieved by:

1. Enabling older workers flexibility to start and finish volunteer or paid employment so as to avoid peak traffic.
2. Providing access to secure cycle parking and showers and changing facilities at employment centres and locations of voluntary work.
3. Recognising the value of employing older people and promoting age diversity in the cycle retail industry.
4. Encouraging and training retirees to engage in voluntary work to support cycling¹.



Figure 47. Sharing knowledge and skills (Photo: Cycling UK)

¹ <http://www.sustrans.org.uk/volunteer/our-volunteers/meet-don-our-volunteer-ranger>

Community Support and Health Services

There is a need to recognise the broad health benefits of cycling and to think beyond cycling as 'just' physical activity.



Figure 48. Positive Spin enables people with dementia and their carers to cycle. A team of experienced cycling instructors deliver the sessions using a range of cycles, with an emphasis on capitalising on the existing skills of the participants and having fun. Organised by Cycle Training UK³ (Photo: Ben Spencer)

 An advertisement for 'Learn to cycle' cycle on prescription courses. It features a yellow sun-like graphic with the text 'FREE COURSES FOR ADULTS'. Below it, there's a silhouette of two people on bicycles. The text 'Learn to cycle' and 'Cycle on prescription' is prominently displayed. To the right, a list of course details is provided:

- Learn to ride in small groups
- Five week courses available from 26 June 2013
- Bikes available
- Space is limited, book your place now!

Figure 49. Cycling on prescription can provide multiple health benefits (Photo: Brent Council)

This can be achieved by:

1. Broadening the narrative on the benefits of cycling to include, not only physical activity, but cycling for therapeutic mobility through the opportunity it gives for social contact, stress reduction, time alone, sense of achievement, independence and control.
2. Promoting cycling on prescription and programmes that help people with different conditions and needs to get out cycling.
3. Providing local programmes to help older people maintain flexibility and balance required for cycling.
4. Supporting cycling as a mobility aid and part of care and wellbeing needs in Personal Health Plans and budgets¹.
5. Learn from the Marmot Cities in tackling health inequalities and encourage cycling as something other than exercise - getting older people more active 'without knowing it'. See Coventry Marmot City programme².



Figure 50. Cycling can provide independence and time alone (Photo: Sustrans UK)

¹ <http://www.nhs.uk/choiceintheNHS>Yourchoices/personal-health-budgets/Pages/about-personal-health-budgets.aspx>

² <https://www.youtube.com/watch?v=BsuI-ayjElw>

³ <http://www.cycleboom.org/positive-spin>

Communication and Information

A cultural shift is required so that the nature of older people's travel is more accurately portrayed. Communication strategies should challenge age stereotypes of decline and dependency and portray positive images of cycling and active ageing. Furthermore, there needs to be wider recognition that other types of cycling are as important as commuter cycling. This should be monitored to provide accurate and up-to-date information to inform policy interventions.



Figure 51. Cycling and e-biking can be fun and contribute to wellbeing (Photo: Raleigh)



Figure 52. Group cyclists having fun (Photo: Sustrans UK)

This can be achieved by:

- Promoting the positive benefits of cycling including fun, freedom, sense of achievement and social participation - the ability to access the outdoors with other people - and the contribution this can make in promoting health and wellbeing.
- Promoting the health and wellbeing benefits of e-biking and tackling the general misperception that e-biking is 'cheating' by holding public 'try-out' events with industry partners.
- Providing information on cycling (benefits, programmes and events) for older people through a range of channels including the National Health Service, cycle industry and also national cycling organisations.
- Monitoring use of e-bikes by distinguishing it from pedal cycling in the National Travel Survey and include the proportion of older people (age 60+) and women as 'indicator species' in national and local cycling targets.
- Conducting further research to factor in the cost-benefit of cycling (and walking) for those age 65 and over in Health Economic Impact (HEI) assessment (e.g. WHO HEAT tool¹) of planned schemes.

Figure 53. The online Health Economic Assessment Tool (Source: WHO)¹

¹ <http://www.heatwalkingcycling.org/>

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