Exploring older women's confidence when route planning

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In-car route guidance is automatic, requiring a minimum of time and thinking. This paper explores the use of personalised information when providing instructions for navigating a journey. We focus on older women with a lifetime of experience. Ten female participants were interviewed to elicit their comfort zone with respect to navigating in a car from their own home. Two routes were then devised for each participant that extended beyond this comfort zone, and presented to them in two different formats. Participants then navigated the route of their least preferred format. Questionnaires and interviews were used to explore the effects of the formats on their confidence, cognitive effort and use of cognitive mapping facilities. The questionnaire data showed that the more detailed instructions supported cognitive mapping processes and the interviews suggested that this support was valued prior to executing the route.

Keywords: cognitive mapping; aging, navigation, personalised information; ICT

1. Introduction

There is increasing concern that the growth of Information and Communication Technologies (ICT) should improve the quality of life and social participation for the broadest of populations (European Union, 2006). On a global scale we have an ageing population and this is clearly evident within the UK where it is projected that by 2031 40 per cent of the population will be over 50 (NSO, 2005). The need to promote independence and active living deep into old age is seen as important both from an individual and a community perspective (House of Lords Science and Technology Committee, 2005). Social inclusion is seen as a prime requirement with ICT having the potential to support social inclusion in new ways (Klironomos et al, 2006). Along with mobility it is regarded as a high priority for the aging population and is increasingly cited as a focus for technological innovation and support (HM, 2008). Technology has the ability to help older people stay in touch with families and friends both in terms of communication and physical mobility. However, a key challenge remains in understanding the needs of diverse user groups and in then applying this knowledge to improve the use of products, systems and services (HM, 2008, European Commission, 2008).

Developments in technology are moving at a rapid pace (Coleman et al, 2010). These changes generally do not take into account older peoples' needs. Furthermore, as older people are generally not early adopters of technology they are typically excluded from the design process (Hanson 2009). Design for All approaches are advocated in the UK government's action plan for consultation on digital inclusion (HM Government, 2008) and stress the importance of this perspective early in the design process and that this is a mainstream issue because of the ageing population. Design for All is not a new type of design but a commitment to include significant sectors of the population that are all too frequently ignored and results in simply better design often benefiting the whole population (Coleman, 2001).

An important area for maintaining social mobility is the ability to continue driving. This is particularly important for maintaining social contacts and activities in everyday life and is relevant to a diverse ageing population (Keith et al, 2007). Navigation software both online and as part of mobile and in-car devices is popular, reliable and increasingly ubiquitous. It provides an accurate route on a "here's all you need to know" basis (Illsley, 2012). However, these systems are not necessarily designed to meet older peoples' specific needs or build on their strengths. In particular they do not draw heavily on people's prior experience and memories.

In this paper we investigate whether taking into account prior experience and knowledge has an impact on older women's confidence when route planning and navigating. We expected that building on current understanding and preferences while removing extraneous instructions would maximise cognitive mapping engagement and positively impact on peoples' level of confidence in the routes provided. We focus on how different presentations of route information affect their confidence in their ability to follow the routes. We specifically investigate whether including personalised knowledge affects this confidence and the engagement of their internal cognitive mapping facilities. We also explore its impact on perceived cognitive effort.

The contribution of the paper is to show that

- Older participants preferred instructions that supported their thinking and cognitive mapping facilities even for routes they already knew.
- There is a real benefit in providing route information that provides step-by-step information before route navigation.
- Participants preferred the step-by-step instructions over those relying on personalised landmarks.

We found no significant evidence that

- Confidence was enhanced by requiring participants to rely on personalised landmarks for known route information by only focusing on previously unknown information.

As our participants were older female participants, these results apply to that group only.

The structure of the remainder of this paper is as follows. In the next section we overview related literature. In section 3 we describe in detail the methodology we followed and describe the profile of the participants. In section 4 we overview the results and section 5 gives our final conclusions.

2. Literature review

Lifelong learning for older people may be problematic because people have a valid attachment to their usual ways of doing things. Furthermore, Hanson (2009) suggests that cognitive difficulties for older people using technology will continue for future generations for two central reasons: a lack of variety in occupation later in life followed by retirement, and complications due to physical and cognitive impairments.

Cognitive factors have received less attention than physical impairments, however Stern (2009) suggests that efforts to promote positive cognitive, as well as physical, stimulation in older adults through occupation and leisure pursuits is vitally important to long-term cognitive and physical maintenance. Furthermore, Kang et al (2009) stress that devices for older people should make use of their prior background, knowledge, age and experience. Several authors suggest that if developers are to avoid alienating older users, a promising area for research is to explore how to capitalise on their cognitive strengths to compensate for their areas of cognitive decline (Hanson, 2010, Fairweather, 2008, Chin et al, 2009).

Lifespan Psychology theories (Baltes et al, 1999) argue that as we age there is an increased need for culture to support our lives and this can be seen as a compensation for aging related to human needs. Information processing theories are put forward as a way of considering cognitive processes for older people. These are divided into two main categories for intellectual functioning: the mechanics (related to new situations) and the pragmatics (knowledge/abilities built over a lifetime) of cognition. Mechanics or episodic memory concerns the biological and genetically determined intellectual processes associated with information processing that we use when faced with new situations and problems**.** Pragmatic cognition describes knowledge and abilities that build up over a life-time, and is often referred to as semantic memory e.g., verbal and factual knowledge.

Researchers have suggested that whilst pragmatic cognition remains stable often until near the end of a person's life, mechanical cognition declines as we age (Craik, 1999, Rabbit, 1999, Hanson, 2009, 2010). Goldberg (2006) argues that younger people's brains have more processing power to apply to novel situations whereas older people have wisdom, which enables them to be very proficient at pattern matching new situations to previous experience. A consequence is that older people's needs must not be excluded from technological development and innovation. Technological innovation is developing at an increasing rate and young people today are likely to face similar feelings of social alienation in the future (Hanson, 2009) if design practices do not shift towards user's cognitive need and personal values. Furthermore for the population as a whole frequently the developed artefact is seen as non-problematic: those using the system need to be elastic (Cooper, 2004) and bend their facilities, needs and requirements to those of the system. Designing well for older peoples' values, preferred methods and procedures is one way to reduce the burden of cognitive adaptations imposed by new technologies.

Route-planning is an area where system support might more clearly relate to older people's usual practices. This domain is particularly relevant to investigate as the proportion of older driving licence holders is rising rapidly. The number of UK female drivers in their 70s has tripled from 11 per cent in 1986 to 31 per cent in 2006. By 2026, nearly 80 per cent of women aged over 70 will be driving licence holders (AA, 2007). Route-planning activities allow drivers to be flexible and maximise their driving ability. They are part of a complex group of activities and involve the application of crystallised cognitive problem solving processes developed over a lifetime.

Lee et al (2008), working with people aged between 20 and 54 reveal that prior to navigation their participants broke up routes into steps and for those parts they already knew might use a schematized sections (e.g., home to the ramp of a motorway). Burnett and Lee (2005) expressed concern that the use of navigation systems will lead to negative long-term implications for cognitive mapping processes. Current technology used over time encourages the unnecessary adoption of new routes and the necessity to drive (as directed) through unknown areas even if drivers wish to avoid doing so. Bryden (2013) confirms that there is a relationship between cognitive aging and reduced mobility and suggests that cognitive compensation strategies to improve wayfinding may increase driving mobility. Large (2013) also argues that system support needs to be designed appropriately to ensure positive benefits when navigating. However, there is little empirical evidence that systems which support cognitive mapping processes in a natural way will enhance independence and this argument requires further research.

Our earlier studies showed that for older participants an intricate use of personal experience including individual preferences, emotions, memories, geographical and historical knowledge are integral to the route-planning activity (Wilson and Curzon, 2006). We found that older people enjoy route planning prior to travelling and that moving around their environments involves thinking about places, routes and areas that are loaded with personal memory. Furthermore, we found that older people make good use of their cognitive mapping abilities in interpreting, thinking about, planning for and navigating their wider environment. They also value keeping their cognitive maps up to date, the routes they select and enjoy reflecting on the changes in the world. These findings relate to theories of embodied cognition that stress that human thinking is affected by and reliant on emotion (Damasio, 1994, Gerhardt, 2004).

Tverksy (2000) asserts that there are three descriptive styles/perspectives (gaze, route and survey) that relate to previous work by Levinson (1996). They correspond to the natural way we experience our environments and to three frames of reference: relative, intrinsic and absolute. A gaze perspective reflects a single viewpoint at eye level and can be adopted for small areas that can be seen from a viewpoint. A route perspective is typically understood as the experience of travelling in an environment. A survey perspective is the experience of an environment from above or on a map whereby landmarks are related to an absolute reference frame and described as relative to one another in terms of an extrinsic reference system (e.g. N/S/E/W). There is overlap between these perspectives, and their essential features can blend. However the premise is that if either route or survey information is consistent then new information can be integrated into our internal representation of the spatial relationship between landmarks independent of any perspective (Tversky, 1993).

The format of experiments considering spatial descriptions may affect the dominant use of perspective from participants. Taylor and Tversky (1996), for example, found that for experiments involving descriptions generated from maps, subjects showed a bias for survey and mixed descriptions over that of route descriptions. This is in opposition to the much quoted study of Thorndyke and Hayes (1982) which suggested a bias in favour of route views. Taylor and Tversky suggest that this is because the latter study may have encouraged the route bias by having a known starting point. In a further experiment designed to explore the validity of a survey bias, Taylor and Tversky (1996) asked subjects to described environments developed from personal experience. Subjects were asked to describe an environment to someone who has never been there or seen a map so they know where the important things are. Here route descriptions predominate but a third of responses contained some description from a survey perspective. So routes from personal experience and a known starting point will encourage a route perspective.

We observed in our earlier work what appeared to be a physical manifestation of the application of spatial perspective (Wilson et al, 2007). For instance, participants who adopted a route perspective made it easier for themselves to think about changes in orientation by tracing routes/part-routes with their fingers. Some supported a survey view by applying physical boundaries to the space they were considering so that they reduced the options for selecting references objects. Generally participants revealed some inclination to work with both perspectives and expert participants were clearly very competent with both survey and route perspectives. Whilst exhibiting these typical behaviours, the most salient landmarks, routes and locations for participants had personal relevance and were not proportional to the physical salience of any feature nor were they necessarily predictable. Participants valued engaging with their own personalised cognitive maps when route planning as this allowed them to update their cognitive mapping facilities, enjoy the planning and focus on their personal preferences and criteria for routes. Such criteria were highly individualised and related to life long experiences and interests. Taylor (1992) shows that descriptions provided in survey or route perspective allow for the creation of accurate mental models as long as the descriptions themselves are cohesive and informative. We therefore took these issues in to account in our study design.

In summary, we have an ageing population living in an era of immense technological innovation and change. Technology can support older people in maintaining their lifestyles. However to achieve this design processes must address their needs early in the design cycle. Work is needed on how to build on older people's values and tried and tested procedures. Our interest is in identifying how everyday ICT can be improved in a way that plays to their strengths, supporting their usual ways of doing things i.e., their well developed and practiced cognitive procedures. Research into aging and cognition suggests that cognitive ageing is not uniform across all modalities and that cognitive strengths build on well-developed problem solving procedures and crystallised skills, which are retained deep into old age but we are less able to apply fluid abilities to learning new skills This means that for domains where skills are developed over a life-time, requiring older people to abandon their usual processes may be detrimental.

Our previous research showed that over and above efficacy, older people's ways of doing things have real personal value for them offering potential for systems to incorporate these. Designing for personal values, which includes a vested interest in maintaining well-used and tested procedures and practices, is potentially a way to support and augment the cognitive strengths of older people. We look at this in the context of route planning strategies and support because it is a domain in which older people have a life-long experience to apply and draw on, and being socially mobile is very important for them.

3 Methodology

3.1 Overview

To assess the effects of different forms of textual instructions on older women's confidence in their ability to follow routes, our methodology followed three phases:

(1) interview to extract personalised information about their locality;

(2) use that information to create routes for the specific participant;

(3) assess the routes with respect to user confidence, engagement with cognitive mapping facilities and cognitive effort.

The last step, assessing the routes, consisted itself of several stages and methods:

(1) Drawing a line on the route to show limit of confidence

(2) Questionnaires to find out:

    (a) The level of confidence in the instructions

    (b) The level of engagement with cognitive mapping facilities.

(3) Interviews

    (a) Gaining deeper insight into their responses

    (b) Rating cognitive effort needed to understand the route instructions

    (c) Determining their least preferred route

(4) Navigating the Least Preferred route

We used data based on questionnaires to quantitatively assess levels of confidence. Interview data was used to give deeper qualitative insight into their responses. In the following subsections we describe each step.

Working directly with older people raises various ethical issues. Technology can isolate people and may make them feel foolish cognitively and physically (Coleman, 2001). It was therefore important that our data collection methods should not add to feelings of self-doubt and alienation (HelpAge, 2002) but should maintain participants' sense of worth and independence and show an appreciation of the their usual practice. Participants were invited to meet the researcher at places where they normally socialised (e.g., local community centre for the over fifties) and provided with refreshments and provided with a gift voucher for a popular chain store as a thank you gesture.

3.2 Collecting personalised knowledge

3.2.1 Background and justification

We first interviewed our participants to extract personalised knowledge about their locality. Our participants had experiences of their environment that could reasonably be expected to be different from another person from the same immediate vicinity. The aim of this step was to gather the information needed to build on this personal knowledge when providing route guidance.

3.2.2 Process

Interviews were carried out with all participants with the explicit aim to both extract routes that finished at the end of the participant's comfort zone, and extract salient personalised features and landmarks.

Two participants were interviewed in their homes, the rest within a community centre. They were told that this was a two part study involving them talking about their knowledge of their local area and beyond, and that a second part to the study would build on this. They were provided with a consent form, bill of rights and brief questionnaire about their age, gender, driving experience and length of time living in an area. It was stressed that the interviews could be terminated at any time and their data would then not be used. All participants completed both parts of the study.

As noted, there is a lack of agreement in the literature as to which is the default between survey or route perspectives (Taylor and Tversky, 1996). Therefore to ensure that we gleaned as much information as possible about important structural features we asked questions that encouraged descriptions of routes and areas from each perspective. For both types the questioning was flexible and responsive to participant responses. In questions prompting route descriptions we asked about places participants regularly travel to, used to travel to, areas and places they like and/or that are associated with their friends, family and hobbies. Further probes considered how they travelled to these places and from where. These were put forward in the form of natural questions with specific prompts such as: where do you shop, go to the doctor's, dentist, etc. Further questions were asked if more information was required to ensure that full routes to the end of comfort zones had been located.

If whole areas emanating from a participant's home were ignored, that area was mentioned by name by the researcher who enquired if they ever travelled in that direction. The researcher ensured that at least some evidence of routes for all four cardinal directions had been considered.

Questions that prompted survey view responses encouraged participants to think in terms of viewing from above or looking at a map. They were asked to describe any features of their local area, to name its centre and something north of the centre. This was to gauge their spatial understanding of cardinal direction and give an indication of their instinctive use of a survey perspective. An aim was to determine edges to each participant's comfort zone: the areas they knew well and could navigate to with confidence. The comfort zone was taken to finish when they were no longer certain and secure about the spatial information being discussed or claimed explicitly that they did not know surrounding areas/routes. Sometimes this was apparent when their spatial descriptions were suddenly inaccurate but generally they stated that they had no knowledge of an area or route. For example at a T-Junction a participant might know the area or road that goes left whilst having no knowledge of where a right turn would take them. Once several edges had been established, routes to these edges were extracted. The comfort zone was then explored a little further, e.g., "Would you ever navigate/drive on from this".

3.3 Creating Routes

The aim of the second stage was to create routes in different textual formats to allow an assessment of which best supports confidence. We used known routes so as to build on the participants' strengths and to consider whether this approach had any value for increasing confidence in the subsequent unknown parts.

We designed two routes for each of the 10 participants. Each involved areas they knew well, but then continued beyond that area. The first route with detailed guidance was the control (C) generated as described below. The second 'personalised' route (P) was a reduced version that did not provide a full listing of instructions for the known part of the route. All participants ultimately viewed and were questioned about both routes.

3.3.1 *Control Routes*

A conclusion of our earlier studies (Wilson and Curzon, 2006, Wilson et al, 2007) was that participants claimed to prefer to concentrate their cognitive mapping facilities on the unknown information when presented with route information. In this follow-up experiment we investigated whether allowing for such a focus enhances confidence in the route information provided. We tentatively expected that participants would gain confidence in having the amount of necessary information presented reduced to that part of the route for which they had little or no knowledge. They could then apply their cognitive mapping facilities to the difficult part of the task. The null hypothesis was taken to be that no differences would be apparent in confidence and engagement with cognitive mapping facilities due to different route instruction types.

Data from the first phase of this study allowed routes to be extracted that went to the edge of each participant's comfort zone. All participants provided at least two full routes that stopped towards the end of their spatial knowledge. Some participants provided whole routes in detail. Some routes were a combination of two or more routes provided at different times during the interview. Routes were selected for the experiment after these sessions had been transcribed. They were checked for completeness and accuracy using the AA Autoroute system. Ones in less congested areas were selected to avoid congestion problems if the routes were eventually navigated. All started at the participant's home address. Whilst a new version of AutoRoute was released in 2010, the older version was used for consistency with our earlier work. The control route was formatted with the full listing provided by AutoRoute 2007. However the route was adjusted if necessary to take the favoured route extracted from the participant. Otherwise no changes were made to the route provided up until the end point they had described. The route was then extended and the end points that had been salient in the participant's responses in the earlier interviews were embedded in the instructions provided by the system. They were of three types.

Type one: Direction and road.

e.g., "Turn right [North] onto A1000 (High Street)"

Type two: Location and direction (stay on, Keep left, take the ___ exit)

e.g., "At Palmers Green, stay on A105[Green Lanes][South]

Type three: Road name changes to another road

e.g., "Station Road changes to Chase Road"

No personalised landmarks were explicitly included to link the known information to the unknown.

Each route went from their home to the end of their comfort zone and then extended 5 steps beyond that point. Five steps were used as previous studies revealed that 5-6 steps was the format generally followed by people providing their own information for a car journey (Wilson et al, 2007, Wilson and Curzon, 2006). This also fits Miller's (1956) conclusion that short-term memory has a capacity of seven plus or minus two chunks of information, independent of the number of bits of information stored within them. For the controls the total number of stages was variable and dependent on how many steps the system generated. On average there were 17 steps including the home address.

3.3.2 Personalised Routes

The personalised routes were generated in the same way as the control routes. However they did not provide a full listing of instructions for the known part of the route up to the edge of the person's comfort zone. We instead reduced this section to two instructions. The first instruction listed the starting position. This was always the participant's home address. The second instruction said to go to a point that was at the end of their comfort zone via some other known point. This via point was always a position of salience identified in the first stage of the study. It was assumed that such locations would act as a landmark to the person. For example, the instruction for participant P25 was "Go via Cat Hill to the Odeon at the bottom of Barnet Hill" where Cat Hill and the Odeon were both locations identified as personally salient to them in the interviews. The words used reflected their own terminology from the interviews to ensure they could clearly recognise the end of their comfort zone and the direction they would be taking to reach it.

These personalised instructions were extended for a further five steps generated by the AA auto-route system in exactly the same way as for the control group. Therefore for the personalised route information instructions were always in seven steps.

3.4 Evaluating Confidence, Cognitive engagement and Cognitive effort

Once we had generated routes, we assessed them with the relevant participant in terms of their confidence, cognitive engagement with cognitive mapping facilities, and perceived cognitive effort. We first presented participants with the two textual sets of instructions developed in the previous phase in repeated measures designs. The risk of confounding results with order effects was addressed by alternating the type of instructions presented first. They were undertaken several months after the participants' knowledge of local areas and routes had been extracted.

We then evaluated whether this personalised and abbreviated information more easily allowed participants to apply their cognitive mapping facilities to the unknown part of the task and in particular how it affected their confidence. Each participant completed a questionnaire after being presented with each route type. These questions focused in particular on elements of confidence and engagement with cognitive mapping facilities. Participants also provided qualitative information via interview after seeing each set of route instructions allowing a brief exploration to how they considered the instructions. After seeing the second set of route instructions, during this interview phase they also selected their least preferred route that they then navigated and rated the cognitive effort required to understand the instructions. Finally they completed the questionnaire again and a follow up interview explored any areas of difficulty or confusion. We look at each data collection approach used in more detail in the subsequent sections.

3.4.1 Drawing a Line

Participants looked at the route instructions for as long as they felt they could draw more sense from them up to a maximum of ten minutes. They were then asked to draw a line underneath the last instruction they were familiar with. This was to gauge the reliability and accuracy of information extracted in the first stage in terms of the assessments made about their prior knowledge and also the information they provided previously. It also ensured that the analysis was not swayed by differences in the accuracy of the comfort zone estimates. The route instructions were then removed from the participant.

3.4.2 Questionnaire

The questionnaire concerned beliefs about what participants felt they could do with the instructions provided. It covered engagement with cognitive mapping facilities and confidence in the instructions. Questions also covered usual route planning practices and attitude to the research methods used.

When measuring attitudes, a problem may be that people express or interpret questions differently. Concepts can also be too complex to be considered from one dimension only. Scales provide a good way to increase reliability by providing a measure that combines the responses from a range of questions that reflect different aspects of a concept (De Vaus, 2002). We devised scales that were accumulated from data scored on a Likert scale and stored in an SPSS package as scale data, as is typical for information expressing an attitude.

Although attitudes in social and psychological studies are typically treated as interval/scale variables and as such are frequently measured using parametric tests there is some controversy about this and they may also be interpreted on an ordinal level of measurement (Garson, 1998). Given the small sample sizes in this study it was not possible to prove that the data followed a normal distribution. Therefore non-parametric tests were used to compare the different responses to personalised and control route information. In particular scales were compared in relation to their median values and also using a Wilcoxon Signed Rank Test. This is a non-parametric test that allows the measurement of a change in participant scores across different experiments.

As with most research looking at people's attitudes it is difficult to gain concrete results (De Vaus, 2002) and as such sometimes a clearer picture of trends emerges by looking at the mean values and standard deviations. Therefore, some descriptive statistics which require a normal distribution have also been included (e.g., means) but these must be interpreted as the average values only for this sample.

3.4.2.1 Scale of confidence. The scale of confidence in the route instructions used was consolidated from six questions on the attitudes questionnaire:

(1) I am confident that I understand these instructions.

(2) These instructions are helpful.

(3) I would be happy to follow these instructions as a driver.

(4) I am confident I could follow this route as a driver using these instructions.

(5) I would be happy to follow these instructions as a navigator.

(6) I am confident I could follow this route as a navigator using these instructions.

For each question the responses ranged from 1-5 with 1 the highest confidence level. This Confidence scale had a good internal consistency for each occasion it was used with a Cronbach Alpha coefficient reported of .975 when looking at the instructions and a co-efficient reported of .923 after the navigation of the least preferred route. This signifies that the responses to items on this scale by participants in these experiments were statistically consistent and as such can be considered reliable.

3.4.2.2 Scale of engagement with cognitive mapping facilities. The scale of perceived engagement with cognitive mapping in the route instructions used was consolidated from eight questions on the attitudes questionnaire.

(1) Some of the route instructions relate to my prior knowledge.

(2) I already knew some of this route.

(3) These route instructions were easy to make sense of.

(4) I can picture some of this route in my mind.

(5) This route would be easy for me to follow.

(6) This route would be easy for me to explain to someone else.

(7) I have learnt something new about this route from these instructions.

(8) I found it easy to link the instructions to my prior knowledge.

For total engagement with cognitive mapping facilities it has good internal consistency, with a Cronbach Alpha coefficient reported of .892 after looking at the instructions and a coefficient reported of .726 after navigation of the least preferred route.

3.4.3 Interviews

The interview focused on knowledge-based questions about the accuracy of their beliefs about their behaviour. Questioning then pursued how they went about making sense of the instructions, asked them to recall the route verbally and on paper (for a friend to follow) and also asked them if anything particular came to mind along the route.

To determine the participants' perception of cognitive effort required to work with the instructions they were asked to verbally rate how much effort it was to put them into their way of thinking on a range of 1-10 (10 being the hardest)

The procedures described in sections 4.4.1, 4.4.2 and 4.4.3 were followed for both routes during the same session. After the second route had been presented to participants, line drawn, questionnaires completed and routes recalled participants were asked which route they preferred least.

3.4.4 Navigating the least preferred route

In the final stage of the experiment participants navigated their least preferred route following the route instructions provided and completed the questionnaire for a third time. They directed the researcher who generally kept moving forward until advised otherwise. Sometimes T-junctions demanded that the driver ask for directions. This was only done if directions were not offered verbally by the participant in time to manoeuvre for a change in direction. Participants were not offered any other support although if they explicitly said they needed to refer to a map, one for the area was provided. Navigating provided another point of comparison between route instruction types and helped confirm the validity of their initial responses when looking at routes. After navigating participants completed the questionnaire and were asked to briefly comment on this activity and in particular to clarify any issues that arose en route.

3.4.5 Overview of participants

This work focuses on an all female sample. However the domain investigated is not limited to women in general. We took an opportunity that arose to work with female participants. This was potentially useful in that older women are a particularly marginalised group in terms of technical innovation. However, further work is needed to extrapolate the results to a wider population.

10 female participants (See Table 1) took part, drawn from two local interest groups, a day centre for the over fifties and a university of the third age (U3A) group. They were initially told about the study by group organisers and friends in these groups. However, ultimately it was their decision whether to take part. The criteria were that they were female, over 50, lived in an area for at least 10 years and had experience driving and/or navigating in a car/van. All participants who wished to be part of the study did so and were highly diverse in terms of age and personal backgrounds.

Ultimately, the results do not show any differences according to the groups they were selected from nor from their driving background. This is probably because the salient factor was that they had to have lived in their local area for ten years or more and had spent years travelling around it.

The average age of the participants was 70 years (ranging from 54 – 86 years) and they had lived in their current areas for an average of 39 years. The oldest participant, at 86, had lived the longest in the current area (76 years). One (P4) had not passed a driving test but navigated friends and relatives on a regular basis. One (P1) had voluntarily stopped driving 2 years previously. The rest drove at least twice a week. All were socially mobile and enjoyed visiting friends and family regularly.

From the open interviews we obtained both route and survey data. All but one (P2) could highlight something north of the place that they knew well, suggesting that they were used to considering their environment from a survey perspective as well as a route perspective. However the data from the questions promoting a survey perspective only minimally fed into the route information used in stage two. These questions did give an indication of the level of social mobility enjoyed by the participants. All were active and travelled in a vehicle at least twice a week, with many participants driving daily. Travelling around safely and easily was something that was important for them. We wanted to work with people who were cognitively able and for whom this research could be received as a positively beneficial small step for people like them when taken as part of the body of research in this area.

Table 1. Background of participants

Person	Age	Sex	Drives	Passenger	Navigates	Years at Current Address	Years in area	Understands 'North'
1	86	F	Stopped 2 years	Twice-a-week	Monthly	40	76	Yes
2	80	F	Daily	Rarely	Rarely	3	43	No
3	69	F	Twice-a-week	Twice-a-week	Weekly	30	35	Yes
4	76	F	Non-driver	Twice-a-week	Monthly	1	30	Yes
5	68	F	Daily	Monthly	Rarely	30	40	Yes
6	54	F	Daily	Rarely	Rarely	54	54	Yes
7	74	F	Daily	Rarely	Rarely	38	38	Yes
8	66	F	Twice-a-week	Rarely	Rarely	27	27	Yes
9	60	F	Daily	Twice-a-week	Rarely	25	39	Yes
10	65	F	Twice-a-week	Weekly	Monthly	6	10	Yes

4. Results

4.1 Overview of routes used

The average length of the routes used to the end of the comfort zones was 6.73

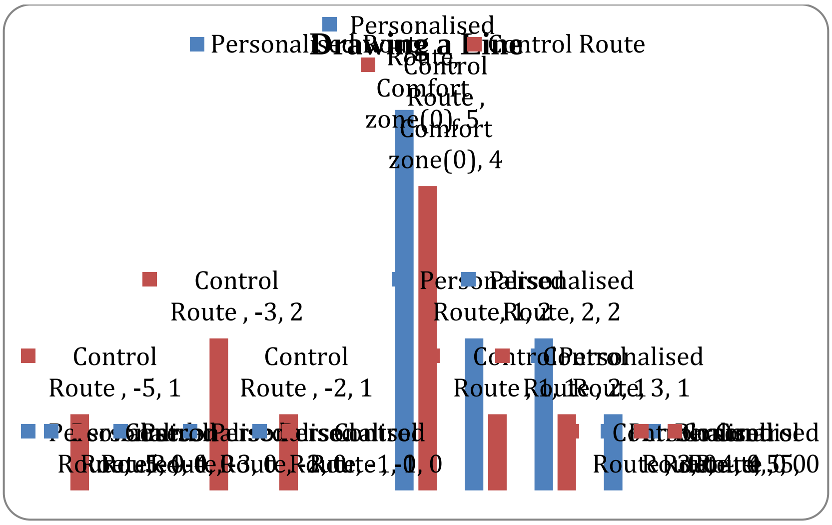
miles. However, in terms of memory and cognitive manageability the length of route was less important in terms of selection than other considerations. Instead the deciding factors were the route's completeness and a clear indication that it ended where the participant's knowledge had become hazy and so was an end point of their comfort zone. This resulted in a minimum length of route selected of 2.2 miles and a maximum length of 13.1 miles.

4.2 Assessing the Route

4.2.1 Drawing a Line

All participants for the personalised routes indicated that they knew the route at least as far as the end of their comfort zone by drawing a line under the last previously known instruction. Five indicated they knew further than expected. The average distance away from the comfort zone for the personalised routes was +0.9 instructions. For the control routes four participants claimed not to know as far as expected and two people claimed to know further. The average distance in knowledge away from the comfort zone for the 10 participants for the control routes was -1.0 instructions. See Table 2 for a summary. Further study is needed to explore these differences. However, there is no evidence to indicate that some variation in knowledge before or after the comfort zone influenced results.

Table 2: Number of instructions known from comfort zone (0)

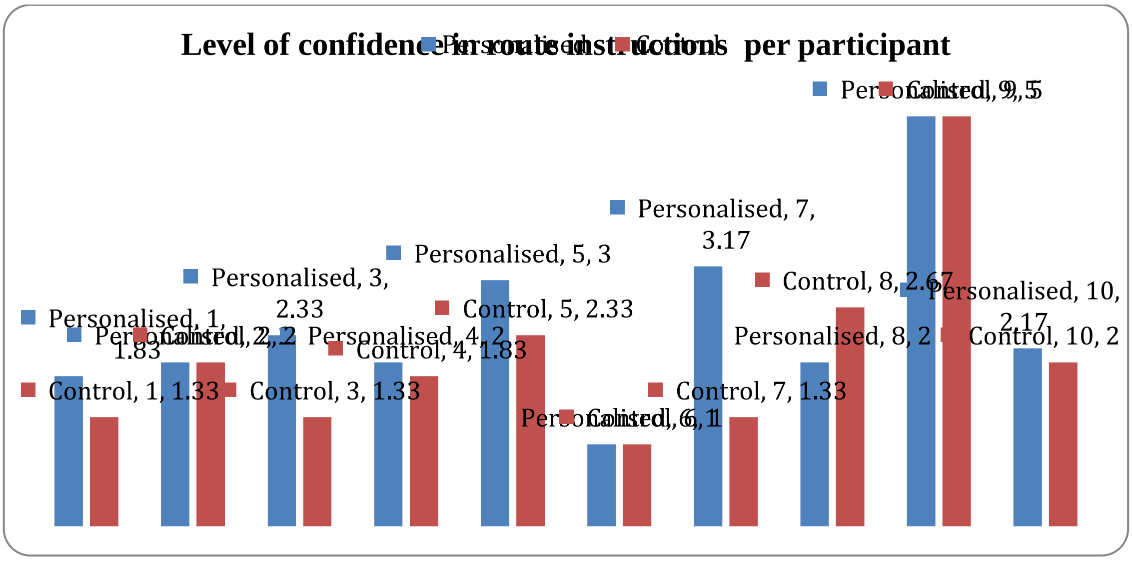


Number of instructions

4.2.2 Questionnaire

4.2.2.1 Confidence when looking at route instructions. Six participants revealed less confidence in the personalised instructions than for the control routes and only one person showed more confidence in the Personalised route. Confidence was measured by using a likert scale from 1 (highest level of confidence) to 5 (lowest level of confidence). Individual scores are shown in Table 3.

Table 3: Levels of confidence when looking at route instructions



Participant Number

The median values for the two route types reveal little change in levels of confidence in the two sets of instructions and a Wilcoxon Signed Rank Test showed these results are not significant (p=0.107). Table 4 shows descriptive statistics for confidence levels for both route types at 25th, 50th and 75th percentiles. The median confidence score for the personalised routes (P) was 2.0833 (IQR =1.0834) and this confidence showed an improvement to a median score of 1.9167 (IQR=1.0834) for the control routes.

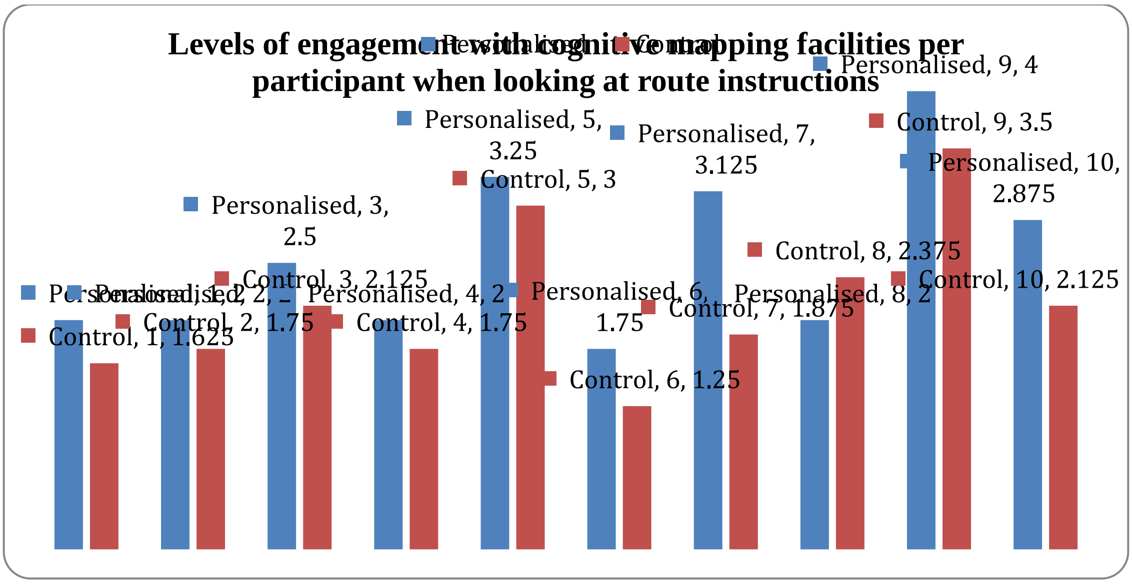
Table 4: Descriptive statistics for confidence levels when looking at route instructions Insignificant result (p= 0.107)

Level of confidence	N	Percentiles		
		25th	50th (Median)	75th
Personalised route	10	1.9583	2.0833	3.0417
Control Route	10	1.3333	1.9167	2.4167

A similar insignificant increase in levels of confidence is shown by considering the means for this sample (p=0.124). The confidence for the route instructions minimally favour the control routes (C). The mean level of confidence for the personalised routes P was 2.450 (SD =1.0803) and for the control routes C a mean level of 2.0833 (SD=1.147).

4.2.2.2 Levels of engagement with cognitive mapping facilities. The measures of engagement with cognitive mapping facilities reveal a significant difference between the level of engagement with cognitive mapping facilities according to route type (Personalised and Control formats). On this combined likert scale, 1 means they strongly agreed that whilst looking at the route instructions they were engaging with their cognitive mapping facilities, 5 meant that they strongly disagreed that they were engaging with these facilities. Individual scores are shown in table 5. 9 out of 10 women were more engaged with their cognitive mapping facilities when viewing the control route instructions than the personalised ones.

Table 5: Levels of engagement with cognitive mapping facilities when looking at route instructions.



Participant Number

The descriptive statistics are provided in table 6. The median score for cognitive engagement with the personalised instructions was 2.25 (IQR=1.1563). With the non-personalised control instructions the median score was 2.00 (IQR=0.8125). A Wilcoxon signed rank test revealed this to be statistically significant (P=0.021).

Table 6: Descriptive statistics for cognitive engagement levels looking at instructions Significant Result (P=0.021).

Level of engagement with cog mapping	N	Percentiles		
		25th	50th (Median)	75th
Personalised route	10	2	2.25	3.1563
Control Route	10	1.7188	2	2.5313

Comparing the means for engaging with cognitive mapping facilities by applying a paired sample t-test also reveals a statistically significant increase in engagement with cognitive mapping facilities (P=.012) when using the control routes (Mean 2.1375, SD= 0.67302) over and above when using personalised instructions (Mean 2.550, SD=0.73645).

Therefore, when looking at the control route instructions rather than the personalised instructions, participants were more likely to believe: that the route related to prior knowledge and understanding, that they could make sense of and follow the route, explain the route to someone else, picture some of the route in their mind and that they had learnt something new from the instructions (see 3.4.2.2).

4.3 Interviews – Gaining deeper Insights

4.3.1 Suggested strengths of routes with step-by-step information

Seven of the participants suggested that the non-personalised control routes, which contained step-by-step information, were supporting them in visualising the known parts of the route. Therefore this may be an important feature in supporting confidence when interpreting the instructions and in preparation for using them en route:

> "I followed the route in my mind because I realised that it was a route I knew so I was really reading to see if it was as I thought it was going to be. I was thinking down there, turn right, down there turn left" [P3 Route C, 125]

Confidence in the known part of the route may also increase confidence in the unknown sections of the route:

> “ Well I know exactly how to get to the roundabout and then I can imagine the rest if you know what I mean” [P2 Route C, 6]

For the personalised route only 2 out of the 10 female participants mentioned that they had benefited from visualising in order to make sense of the instructions (P1, P6). The most extreme position for this was taken by P5. After considering the personalised route she claimed that her mind had initially gone totally blank and whilst she knew she knew how to get to the end of her comfort zone she did not recall it easily. It did not seem that many of the female participants were actually happy to accept that they already had the knowledge to successfully negotiate a route to a destination despite informing the researcher of the route originally and clearly indicating in the previous step that they knew as far as the end of their comfort zone

There was some indication that distance measurements in the routes were hard to comprehend accurately. The total miles was placed before each instruction and the distance to the next instruction after the previous instruction e.g., “Mile total 1.1 Turn RIGHT (North) on Lincoln Road for 0.2 miles”. Several of the participants asked for this distance information to be before the subsequent instruction (e.g., “In 0.2 miles Turn LEFT”.

The misinterpretation of distance was sometimes more subtle. There are issues with the perception of distance as indicated by the instructions and the notion of how far into the instructions participants appeared confident in their interpretation. P7 suggested she could see much more of the non-personalised control route in her imagination. However when she drew a line she indicated that for this favoured control route she knew 76% of the route presented (12.4 of the 16.2 mile), whilst for the personalised route she knew 82% of the route (7.7 miles of the 9.4 miles presented). This suggests that the imagining, visualising or picturing the route may have special qualities over and above usual measures for quantifying understanding.

P6 was also less confident about the first personalised route P where she believed she knew far less of the route.

> "I suppose I am least confident about that first one because I don't know where I am going...[but for the Control route] Friday Hill I'm almost there aren't I, Friday Hill was almost the end of the journey wasn't it? There was only a couple more instructions after that, a couple of roundabouts" [P6, 92]

However after drawing the line under the last known instruction for the personalised P route she showed she knew 6.5 out of 9.5 miles (68 % of the route), whereas for the control route she knew 5.2 miles out of 7.7 (67% of the route). For the personalised route the first section (6.5 miles) was only two instructions whereas for the control route C the first section (5.2 miles to Friday Hill) was 10 instructions. The unknown parts were five instructions each. Again this shows that people infer distance information from the layout of the instructions, which in this case was meaningless but affected preference.

P3 took this further by explicitly suggesting that the instructions could be grouped together to reflect their density, with gaps in the instructions when there was a long distance requiring no change in orientation or new information:

> "It might be all right if they were broken up, so there was a gap. So you can just, you think I've done the first bit and then the next bit and then the next bit. You know because otherwise you've got to keep looking at it." [P3, 43]

> "So you break it up maybe into groups of five?" [Re, 44]

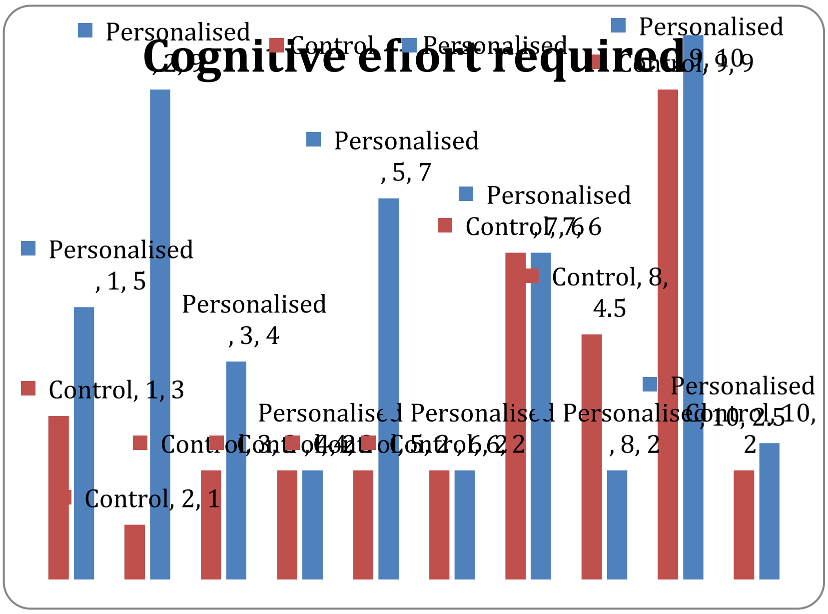
“Yes whatever makes sense sometimes, sometimes you need a lot close together and then you’ve got a long way to go before you need the next lot. That might be a suitable break.” [P3, 45]

“Yes so when you have a long distance in between then have a break.“[Re, 46]

4.3.2 Cognitive effort

Participants were asked to rank the routes on a scale of 1-10 for how much effort was needed to put these instructions into their way of thinking (one being the least effort). Their individual results are shown in table 7. For the personalised routes this gave a median value of 4.5 (IQR=5.5) compared with a median value of 2.0 (IQR=2.8750) for the non-personalised control routes (see table 8).

Table 7: Cognitive effort required when looking at route instructions



Participant number

This follows the trend for the stated preference for the control routes but three of the participants who verbally claimed to prefer the control routes actually scored them the same on this scale for both route types (see table 7 for individual scores on this scale). However a Wilcoxon signed rank test revealed this to be statistically insignificant (P=0.128).

Table 8: Descriptive statistics for cognitive effort when looking at route instructions Insignificant result (p=0.128)

	N	Percentiles		
Cognitive effort		25^{th}	50^{th} (Median)	75^{th}
Personalised route	10	2	4.5	7.5
Control Route	10	2	2	4.875

Participants were asked to recall the routes verbally and on paper. There was no indication that the personalised routes or control routes benefited memory in the short term for the unknown information.

4.3.3 Least preferred route

We expected that participants would prefer the abbreviated personalised route. It directed them to a declared point of personal salience at the end of their comfort zone via some other known point. We suspected that as a result they would find it easier to focus on the 5 new steps in a total of seven thus helping to support their thinking. However, 9 out of 10 female participants stated verbally that they preferred the full instructions from the standard AA route information. A chi-square test for independence indicated that this current sample showed a significant preference as compared to no expected preference for the non personalised route (p=.011*).*

4.3.4 Summary of interviews

7 out 10 participants stated that the control routes provided them with step-by-step information that supported them in visualising the known parts of the route. There was some indication that this gave them confidence in the unknown parts of the route. Only two participants mentioned visualisation in connection with the personalised abbreviated instructions. Furthermore the more instructions for the known part of the route, the more of the route that participants felt they knew well regardless of their stated knowledge. This suggests again that being given support for visualising the routes may infer confidence regardless of prior knowledge.

4.4 Navigating the least preferred route

Participants were driven their least preferred route. Only one person navigated the control route and they executed this without any issues arising. Nine people navigated their personalised route, which we focus on in this section. All participants managed to reach the destination. We overview results from the observation, then analyse levels of confidence and engagement with cognitive mapping facilities after driving.

4.4.1 Observations

There were four notable issues, these occurred outside of the comfort zone unless otherwise stated:

- For some participants distance measurements in the instructions did not translate well to real world activity.
- For some it was hard to spot road signage in order to match them to the instructions.

- Some mentioned the need for more landmarks.
- Diversions appeared to impact confidence

Distance issues were raised by four participants (P1, P3, P6, P10). P1 was the only one who referred to a map. On the first approach to her penultimate instruction her interpretation of the mileage was that she had overshot the road concerned. When she retraced her route, she realised that she had not done so, asked to check on a map and successfully located the road the second time. For the first unknown instruction she took a wrong turn although she carried this through to good conclusion but road signage did not support her at all in making a decision on which direction to take. P3 was uncertain about some distance information but claimed this was due to the format of the instructions. She preferred the distance travelled to be listed before the destination rather than after the prior point. Similarly, P10 stated that issues with distances supplied were in the wrong format and would be better listed before the destination. P6 also claimed that it was difficult to judge the distance and this increased her reliance on road signage. This could prove problematic (see point 2 below).

Problems with matching road names in the instructions with those in the world were mentioned with concern by 6 participants (P1, P2, P3, P6, P7, P9). This was evident whilst navigating or in the brief discussion afterwards. P1 and P3 claimed to have difficulty matching road signage and for P1 this was complicated by issues with interpreting distance. P2 was a little anxious for the first two instructions in the unknown section as no road signage was seen that indicated she was on the right road. However for the third instruction a road name was seen and confidence restored. P6 did not spot the relevant road signage at a T-junction. She turned back 0.6 miles, then approached the T-junction a second time when she did note a small road sign which matched the instructions. P7 could not see the road name relating to the penultimate instruction and overshot it for a short distance before returning to it. P9 missed a road name on the third instruction of the unknown section of the route, then realised something was wrong and simply turned round and retraced her steps and took the correct turn.

Two participants (P3, P10) stated that they would prefer more landmarks to be included, so they could ensure that they could confirm they were on the right route.

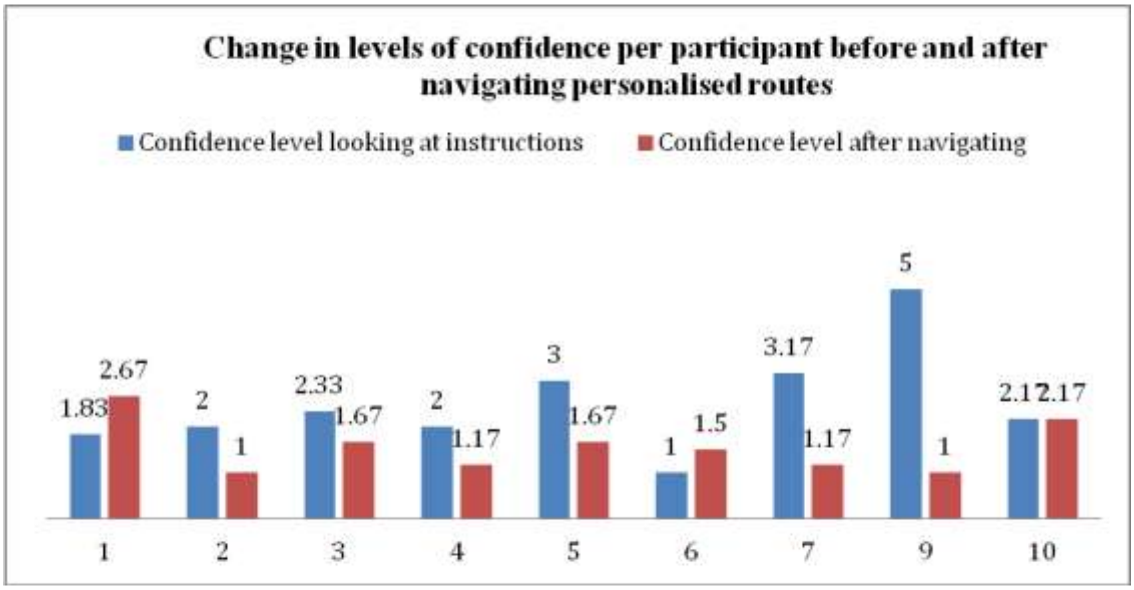
Finally, of the 9 people navigating the personalised route there were two occasions where there were unexpected diversions in the road. For P5 this was within the comfort zone (P5) and this did shake her confidence and resulted in her taking another route which by-passed the via point and went straight to the first instruction outside of the comfort zone. Her navigation was almost intuitive as her lack of confidence did appear to disturb her thinking process however she managed to navigate around this successfully and then asked not to navigate home (although this was not a requirement). For P10 the diversion crossed the boundary between the comfort zone and the unknown parts of the route. She did manage to overcome this and whilst she would have liked a map did not refer to one but thought about the problem in the world. She seemed very relaxed.

In summary, navigating the routes was successful. Despite most participants being driven the personalised shortened routes that they least preferred they found navigation achievable. However, there were issues concerning misjudgement of distance, locating road signage, a need for more landmarks and unexpected diversions. Despite reaching the destination some of the participants seemed uncertain of their own capabilities in the world and unsure that they were interpreting the written information in the world effectively.

4.4.2 Levels of confidence before and after navigating

Of the 9 people navigating the personalised (shortened) route, 6 were more confident about the instructions once they had navigated the personalised route than when they first looked at the instructions. Two participants became less confident after navigating the personalised route and for one participant there was no change. Individual scores are shown in table 9.

Table 9: Changes in levels of confidence before and after navigating.



Participant number

Descriptive statistics are provided in table10 below. The median score for levels of confidence after viewing the instructions was 2.1667 (IQR=1.1666), and the median score for levels of confidence after navigating using the personalised instruction was 1.5 (IQR=0.8934). A Wilcoxon signed ranked test revealed this was not statistically significant (p=0.058).

Table 10: Descriptive statistics for levels of confidence before/after navigating. Significant result (p=0.058)

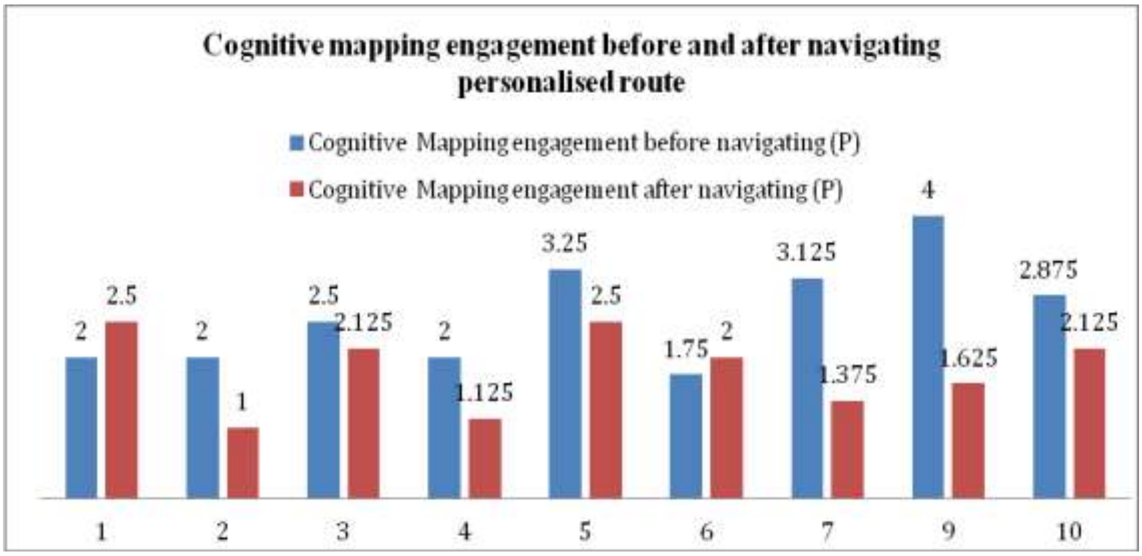
Levels of confidence	N	Percentiles		
		25th	50th (Median)	75th
Before navigating	9	1.9167	2.1667	3.0833
After navigating	9	1.0833	1.5	1.9167

The one participant who navigated the non-personalised route was more confident afterwards, scoring 2.67 on the Confidence Scale after looking at the instructions and scoring 1.83 afterwards.

4.4.3 Levels of engagement with cognitive mapping facilities before and after navigating

After having navigated the personalised routes there was a statistically significant enhancement in participants' engagement with their cognitive mapping facilities as measured in this study (p=0.028) with 7 participants being more positively engaged (2 less). Individual scores are shown in table 11 below.

Table 11: Engagement with cognitive mapping facilities prior and after navigating



Participant number

Descriptive statistics are provided in table 12. The median score for this engagement with the personalised instructions was 2.5 (IQR=1.875) and after navigating with the personalised instructions this level increased to 2.0 (IQR =1.6 inter-quartile range). The Wilcoxon signed rank test showed this to be a significant increase in the level of engagement with cognitive mapping facilities of p=0.028 after navigating the personalised routes over just considering the instructions.

Table 12: Descriptive statistics for cognitive engagement levels before and after driving personalised route. Significant result (p=0.028)

Level of engagement with cog mapping	N	Percentiles		
		25th	50th (Median)	75th
Before navigating	9	2	2.5	3.1875
After navigating	9	1.25	2	2.3125

The mean averages also showed a significant improvement in engagement with cognitive mapping facilities (p=0.029) with the averages improving from 2.6111 (SD=0.75375) after looking at the instructions to 1.8194 (SD=0.56289) after the personalised routes had been navigated.

4.4.4 Summary of navigating the least preferred Route

All participants navigated their least preferred routes: 9 their personalised routes and one the control route. All reached their destination although there were some problems with distance interpretation and locating signage in the world and some indication that more landmarks embedded in the instructions would be useful.

There was a significant increase in engagement with levels of cognitive mapping facilities after navigating the personalised routes (p=0.028). This increase in engagement with cognitive mapping facilities mirrored the levels of engagement that participants declared after viewing the step-by-step control routes (6.3.3.2). However whilst 6 participants showed an increase in confidence after navigating the personalised route this was not significant (p=0.058).

5. Conclusions

We aimed to explore whether for older women an application of their own experiences and practices could benefit the usability of technological support for everyday cognitive tasks in ways that were beneficial and supportive of their usual processes. In particular we considered route-planning behaviours and the engagement of cognitive mapping facilities and issues surrounding confidence.

Previous work led to a suggestion that our older female participants would prefer personalised abbreviated route instructions which relied on participants declared prior knowledge and only gave them step-by-step instructions for the unknown information. However 9 of the 10 participants, after they had looked at the two types of route instructions, showed a significant preference for the step-by-step control routes over and above the personalised ones. This is despite the fact that the abbreviated instructions referred to routes they had previously provided. They also confirmed after reading the instructions that these shortened routes were well known to them.

Levels of engagement with cognitive mapping facilities followed stated route preferences with 9 out of 10 participants revealing themselves to be more engaged when looking at the control route instructions rather than the personalised and abbreviated set. The scale of engagement with cognitive mapping facilities referred to abilities to relate information to prior knowledge, to learn from the information and to picture the route in their mind. This significant rise in cognitive engagement did not relate to their subsequent ability to remember the unknown parts of the routes. Interviews were used to delve more deeply into the reasons behind these results and there were indications that the step-by-step control routes supported these participants in visualising the known parts of the route. This ability to visualise the route meant that they believed they had a good understanding of a greater proportion of the route than for the personalised routes whether or not this was the case. This suggests that being able to simulate the route in the mind supports feelings of self-sufficiency and expertise.

However, we obtained no concrete results for levels of confidence or cognitive effort involved, although the direction of statistics followed the direction of the significant results with confidence appearing higher for the control groups and cognitive effort reduced with the step-by-step instructions being easier to make sense of.

Once the 9 participants had navigated their least preferred personalised route, there was a significant increase in the level of engagement with cognitive mapping facilities. There had clearly been an engagement with the task. However despite successful completion by all participants of the navigation exercise it is unclear whether the presence of the driver may have increased their persistence and made them feel safe in the experience and more committed to continuing than otherwise.

Given the difficulty in achieving concrete results in research assessing people's attitudes and responses (De Vaus, 2002) some of the evidence presented is to set out consistent trends that because they are repeated between measures have some credence even though they are not all statistically significant. In analysing our data there are several emerging themes with all statistics following the direction of stated route preferences and engagement with cognitive mapping processes but larger samples would be required to confirm statistical significance. In particular these themes are revealed through the measures for cognitive effort and confidence.

These experiments indicate that when preparing to undertake a route the fullest information supports the visualisation and this may also influence positively the level of confidence in interpreting and perceiving unknown route information. However, further work is needed here. There are several reasons why these results may not have been conclusive: possibly the measures used were not entirely suitable, or the female participants had fairly consistent levels of confidence in their own ability to work with route instructions and these remained fairly stable regardless of format so that confidence was not affected by the change in route formats. A larger sample would determine if more significant results could be achieved or not.

There were some other limitations to the study. The participants were all female, however this is an area that clearly relates to men as well and further work should investigate these results across genders. Furthermore, there were only a small number of participants used and particularly for the confidence scale the effect or otherwise of the two treatments could be more clearly interpreted. Furthermore, whilst great effort was taken to control the explicit use of landmarks, some road names and other route features may still have been particularly salient to a participant and unknown to the researcher.

It seems reasonable to suggest that more work on system support that engages cognitive mapping facilities is worthwhile in the domain of route-navigation.

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