Chapter

Attitudes and Behaviours in Relation to New Technology in Transport and the Take-Up amongst Older Travellers

Joan Harvey

Abstract

Numbers of older people are increasing and this will continue for several decades to come. With that, there are changes as we age that can affect or impact upon our travelling and transportation needs and behaviour. In addition, there is an almost universal problem that many of all ages people have low levels of computer literacy. Transport may well look very different in the future. Not only automated vehicles, but also new transportation systems, such as Mobility as a Service [MaaS] and the likely developments in public transport that incorporate real time travel information, facilities and ease of use information all mean that older people wishing to travel will necessarily have to engage with some forms of new technology. The new systems will need to be personalisable to individual travellers. This chapter considers the needs of older travellers and how new technology can meet some of those needs and what is necessary for it to be appropriate to, and usable by, older travellers.

Keywords: new technology, older people, travelling, attitudes, behaviour

1. Introduction

This chapter is in three main sections, plus a conclusion at the end.

The first section covers what happens as we get older, in terms of abilities, skills cognition, psychological and social changes and changes in technological 'savvy' or awareness.

The second section looks at how changes in transport systems can be made much more useful and usable for older people; in addition the vision of the future that is MaaS in the UK is considered, especially for the older and more infirm category of older people.

Finally there are a number of considerations [such as ergonomic ones] in terms of the older traveller using new technology to aid their travel, and what the requirements are for that to work as well as possible.

2. What happens as we age?

2.1 Getting older- what changes cognitively?

Being 'older' used to apply to people aged over 50, but in modern times it largely refers to people who are at least past retirement age, which would be between 65 and 70 in most countries, right up to 100+. It is possible now to find large numbers of people aged over 80 who are highly active. However increasing longevity brings not only more fit older people, it also means more older people with limitations and disabilities and more people generally with low levels of computer literacy [1].

Some things do deteriorate with age, including many cognitive functions, for example memory and retention, but also some skills such as navigation and situational awareness. Response times, such as reaction times in the event of an emergency also slow with age, even more so when there are multiple demands on attention and attention-switching and/or distractors (for example see [2]).

2.1.1 Cognitive age-related declines and gains

Between the ages 20–80, there is a decade-by-decade reduction in processing speeds, working memory, cued and free recall: these are real reductions in every decade, although a steeper decline between 70 and 80 [3].

There are also age-related gains:

- habituated skills and sustained attention, past experience allowing better anticipation,
- increased vocabulary and knowledge,
- recognition and other crystallised abilities that rely on culture-related lifelong learning and these increase throughout adulthood and are preserved in healthy ageing; gains may also relate to older adults adopting age-counteractive measures to compensate for losses. The evidence for functional reorganization [the plasticity of the brain] and compensation along with effective interventions does hold some promise for a more optimistic view of neurocognitive status in later life [4–6].

2.1.2 Distracters and slower processing

There is ample research showing the distraction of cellphones causing a deterioration in driving performance in terms of reduced ability to react and respond; whilst this occurs at all ages, it can be a particular problem for older people because it involves switching attention [7]. We also know that visual field declines with age but this is not universal by any means [8]: we cannot assume that all older people necessarily have poor eyesight, and transport or other policies reflecting this that restrict driving privileges for older people have no scientific foundation- in other words, restrict drivers if you wish by testing visual field, but do not do it by age. Decline in situation awareness relates to shrinkage in the field of view but not to cognitive decline: these constitute an issue in perception of travel-related information but mean that training to improve situation awareness may have some real value.

The findings of slower processing, working memory and attention-switching declines, are clear but there is huge variability for all of these: reasons might include health status and fitness being huge positive indicators for self-efficacy and achievement for older people whereas stress levels have negative impacts etc.. Not only that, but pathological age-related changes (such as Alzheimers') can be undiagnosed for up to 10 years, so not only might abilities decline with age, but also there will be declines associated with diseases of which the individual is unaware; for example perceived difficulty in using everyday technology increases in people with mild cognitive impairment [but may be attributed simply to just 'getting older'] and accentuates in mild-stage dementia [9, 10].

Older people displaying lower levels of cognitive skills may actually be due to mechanisms that were present earlier in life that generate *life-long* differences rather than due to ageing, for example due to less-enriched environments; indeed, research on the brain's plasticity implies that changes continue throughout life and thus the option to enrich the environment to facilitate positive changes at any age point presents a distinct possibility [11], such as improving 'situation awareness' by using driving simulators.

From this, an unwillingness to engage with new technology may be a life-long issue but at the same time it is not too late to change, albeit with much training and support. In terms of transport and developments of travel 'apps', many older people may have relatively little experience of journeys, some may have travelled only by plane to a holiday resort and little else by way of organized or unorganized travel (see [12] showing for example lower bus use than planes) and so an 'app' to help with trip-planning may make little or no sense to them.

2.1.3 Other psychological mechanisms that decline

Other psychological mechanisms that decline with age include situation awareness as mentioned above, navigating skills, episodic and autobiographical memory, etc. [13–15]. Losses of episodic memory involve the link between an image [venue] and its name being lost, but better signage linking a name to a picture can help in this situation, and could be adapted to be possible with wearable devices, which could also help those with early dementia be able to travel without worrying about knowing where they need to be. There are many 'visual' or 'conceptual' maps that show imagery linked to names; for example as early as 1968, Fisher developed a 'conceptual map' of Newcastle upon Tyne, using image-name links plus perspective to enable travellers to negotiate the city centre [16]. Sustrans maps showing cycle routes utilize a similar approach. To be amenable to older travellers with memory loss, this approach could be developed for a touch screen with increasing levels of detail.

2.1.4 Age-impaired task performance

Performance of tasks can be impaired or counteracted, enhanced or neutrally effected by age [17]. Older people may learn how to counteract any inability to perform a task or their experience or knowledge might actually enhance what they are doing- examples include driving different routes to avoid difficult situations, driving more slowly to compensate for perceived slower response times, or driving in daylight only, or to avoid glare, or using familiar routes [18, 19]. Age-impaired tasks are not only those that rely on complex switching of attention or speed of response, they may also be impaired by high levels of emotion or stress [such as frustration of being late], both of which directly affect memory. An age-impaired task may be one at a forced pace, whereas an age-counteracted one would be where the older person, aware they may be slower, works at their own pace. Inhibitory responses are less efficient with age so it becomes more difficult to access relevant information and delete old information from our processing; again, many people learn to compensate for this, for example by keeping to simple or more habituated tasks that require fewer or lower inhibitory responses and which appear to be unaffected by ageing [20, 21]. Increased amounts of or new travel-relevant information would mean that processing may be problematic if it interferes with the existing information travellers hold in their memories about the trip (see for example [22–24]); additional information could only be of value in this situation if precisely targeted at the person and the specific journey, and not adding too much new information to process. However older people are very able to maintain sustained attention, so tasks that require this but not divided attention may be relatively age-neutral, and in any event even divided attention tasks may be improved with practice and training in older people [25, 26].

Age-related changes may disadvantage older people in an increasingly screen and button-based world [23]. The over 70s in particular exhibit difficulties with touch screen interfaces and the navigation logic of applications [27]. Too much information can present anybody with a processing dilemma, particularly older people; for example over-complex display systems of travel information, either at sites or on mobile apps, may present them with something they struggle to deal with and thus avoid. So there is the problem that any declines in cognitive processing could lead to reduced or no use of new technology, which in turn leads to exclusion of older people. There are many recommendations that can alleviate or at least mitigate such issues, covered later in this chapter.

2.1.5 Summary of cognitive changes with age

In summary, older people can be slower to respond, can have reductions in working memory capacity and computing span, problems switching attention, decline in visual field; episodic and autobiographical memories decrease most and aids for retrieval are needed; there is difficulty in moving onto new topics as inhibitory mechanisms cling to previous topic; less attention focus especially when tasks increase in number; situation awareness is worse with age; slower navigation skills. Memory is also negatively affected by emotion or stress but is improved by enriched environments. There are real reductions in every decade, although a steeper decline between 70 and 80; in contrast, vocabulary and knowledge-related measures rise slightly with age right up to 70 and then level off, and age makes no difference to recognition [3]. The plasticity of the brain, functional reorganization and compensatory increases in frontal lobe activation mean that the brain can change throughout life and there is evidence that these can be encouraged by interventions so many of these changes can be influenced for the better. There are problem of early undiagnosed pathological ageing diseases, affect working memory. Restricting insurance policies etc. should be done on the basis of testing visual field but not by age.

2.2 What else changes?

The psychological factors and traits that decline/change with age include risk taking, risk awareness, motivation, personality and resistance to change.

2.2.1 Personality

In terms of personality, there is no evidence of changes beyond the age of 30, but it must be said that the age period 16–30 is one of change in most psychological factors and indeed is associated with changes in the brain and hormones. A relevant personality trait in this respect is openness to change, which is likely to be normally distributed and in terms of openness resistance to change is a default position in terms of evolutionary psychology (see for example [28]); and there is evidence of increasing resistance to change with age, although that needs to be unpicked in order to understand it: for example it may be associated with low-involvement whilst high-involvement may be associated with changing attitudes; this is important if we are looking at technology engagement with which older people may exhibit low involvement. In addition, attitudes changed can just the same change back again; so positive changes in attitudes to technology will need to be reinforced if they are not to revert to earlier attitudes [29].

2.2.2 Attitudes and change

More negative attitudes towards computers by older people are related to perception of less comfort, efficacy and control, all of which have been shown to be improved by increased experience [30]. In addition, the literature on change and change management points to low trust, perceived lack of competence, poor communications, not understanding the need for change, exhaustion/saturation and changing the status quo [away from habituated behaviours] as all being culpable. When people are asked to articulate their reasons for resistance, risks outweigh the benefits, they do not have the ability to change, perceive that things will be made more difficult, not meeting their needs and so on are all cited [31]. Many of these issues are relevant to the unwillingness of older people to engage with new technology.

2.2.3 Unwillingness to reduce driving and the role of affect

As already mentioned, older people when driving often engage in age-counteracted behaviours [self-regulation] and are thus less likely to take risks and avoid difficult driving or travelling situations. Less peer pressure and increased self-awareness may influence age-counteracted and compensatory behaviours for older people view limitations [8, 32–34]. Many older drivers will be unwilling to reduce their driving because of the increased inconvenience, loss of social activities and lack of suitable alternative transport modes, loss of independence and increase in social isolation etc. [35–39]. The relationship between many people and their car is not so much an *economic* one as an *affective* one and they make choices about travel mode using the *affect heuristic* [40]; this means that comfort, convenience, feelings of risk and security, etc. all play the larger part in the decision. Older people may be more time-rich and potentially more money-poor than they were when working, but decisions on transport mode are still likely to be affect-driven, and poor public transport provision must surely exacerbate that situation (e.g. [41]).

2.2.4 Risk taking and risk awareness

Risk taking and risk awareness can be critical for all travellers. The reasons for accidents differ considerably between older and younger people and most insurance premia follow a U-shape with age, with by far the highest premia at <25 yrs., dropping to age 30 where they remain low until the late 60s. Accidents and injuries are caused by different elements at different ages: selecting and processing information in a complex task may be causative for older drivers accidents, whereas overestimation of personal skill, sensation-seeking and a preference for risky driving, reaction times and ability are causative for younger drivers [32, 37, 42, 43].

2.2.5 Some health issues can improve

Ageing also has some basic physiological aspects: it is related to changes in the cardiovascular and cardiopulmonary systems; however deficits can be reduced by training, practice, aerobic exercise and these also may improve the efficiency of neural processes, which we can see in healthier older adults' increased take-up of technology [44–46].

2.2.6 Summary of non-cognitive changes

Therefore we can say that increasing age is associated with more positive attitudes and emotions and an optimistic bias; self-awareness of functional decline leads to many age-counteracted or self-regulatory behaviours; resistance to change is the default position and slowly increases through adulthood; older people have a lower self-assessment of skills and abilities; increased lack of confidence, fear and anxiety with regard to new technologies, perceived less comfort with, efficacy or control over computers, dehumanisation all affect motivation to engage with new technology. Attitudes change [to new technology] requires reinforcement otherwise it will decay. Self-efficacy is predictive of better health in older people- relevant to adopting new technology.

2.3 How do people learn new technologies or resist becoming "tech-savvy"

2.3.1 Age related factors

Learning of new technologies is a complex challenge for many older adults if it does not suit individual capabilities; reasons include perceived loss of control, lack of confidence, not seeing the need, wanting to retain the status quo and so on, many articulated in this chapter already [47–51]. Reasons for adoption of new technology *de facto* follow the reverse of these, and would include feeling confident and in control, perceiving a current need and recognising a future need plus past relevant experience [52, 53].

Since much information technology only began to become commercially available in the mid-1980s, so younger people have a 'head start' and often tend to be good at digital technologies; they invariably use them at school or at work in the form of computers, laptops or smartphones, and even internet access in households with an adult aged 65+ have now risen to 80% in 2020, and online shopping has increased massively especially in 2020 [54]. Those older adults whose occupations involved computer use, e.g. engineers [52, 53] are more likely to perceive the need for and be able to learn and use new technologies with confidence.

However the evidence is that most people, across all ages, are a long way from being tech-savvy, and that also includes a large proportion of older people; as technology develops, it may always be ahead of older people, although if the development rate levels off this may be less of an issue in years to come.

2.3.2 The digital divide

An international study by OECD [1] attempted to quantify the differences between the broad population and the technology elite: data collected from over 200,000 people aged 16–65 in 33 countries yielded four levels of technology proficiency. The findings suggest that over 65% of UK adult population are at Level 1 (can do tasks typically requiring the use of widely available and technologies, applications such as email software or a web browser") or below. The OECD average for level 0 or 1 is 69% with Japan 66%, USA 67% and New Zealand 56%. So there is a clear *technology- divide across all ages*, which can be proposed to be larger than any *age-divide*.

Therefore for designers to target a broad consumer audience at any age, they must:

- keep it extremely simple, meaning little/no navigation required to access information or commands required to solve a problem;
- have few steps or operations, few monitoring demands;
- allow identification of content and operators through simple match
- include no need to contrast or integrate information.

More importantly for our considering older people here, the OECD study did not include people aged over 65, where the percentages of being Level 1 or below should be considerably higher. It is clear that there is a responsibility- and benefit- for designers of current and future ICT to make it accessible, affordable, anxiety-free and helpful so older adults can use it [55]. Most ergonomists and gerontologists would agree that designing for the disable user would be similarly useful to all.

Page [50] suggested that whilst older users may show a keen interest in learning and using technology, they often do not feel fully equipped to do so. Motivation to learn may also be a function of utility; this means that over-complexity may present older users with a problem beyond what they can manage [29].

One key area for non-engagement with technology relates to user confidence in own abilities, fear and anxiety [53, 56]. Technology has been shown to be a source of anxiety amongst older users, for example concerning loss of privacy, lack of confidence, a perceived lack of need and an unwillingness to learn through trial and error [55, 57, 58].

Working with computers, tablets or smartphones inherently requires working memory and fluid intelligence, the ability to reason and solve new problems independently of previously acquired knowledge, which are also predictive of each other, along with attention-switching (e.g. [59]). Whilst training on working memory can improve general fluid intelligence, the effect is dosage-dependent, so the more training, the greater the improvement. The implications of this for training older people in new technology are therefore considerable (e.g. [60, 61]).

Instructions and manuals are often not clear, difficult to follow, and need to be improved; there is some research on this already, but more is needed. Examples of where this has been done to very good effect, in the commercial and Government areas, is the work on instructional text of James Hartley (e.g. [62]); examples of this approach can be seen in the design of entirely visual passenger safety information in airplanes and some instruction formats. Too much instructional information in a manual or Web Page, or too much hierarchical and negative searching can lead to cognitive load issues [63, 64].

2.3.3 Summary of section

In summary, *there is and will continue to be a digital divide in tech-savviness*- albeit not total illiteracy on the lower side but a divide nevertheless, which extends currently down to 16–25 year olds. Older people may be less confident and poorly motivated to take on new technology, but there is a strong role for additional training to help with working memory and fluid intelligence and a need to develop good instructional material to support this. Personalised and self-regulated learning should be available for all new technology.

3. How can transport system changes benefit older people?

The UK Government has published details of a MaaS approach [65], which would allow for personalized transport in some ways; this would include ticketing and many other services through single systems – early examples include smart-cards that can allow the user to go from mode to mode without any reticketing. In the longer run, it would move towards a more bespoke service that can benefit the less mobile by allowing transport to be summonsed to precise destinations for personalized journeys. This is one example of new technology working to enhance and improve, and for the less mobile actually enable travel to be undertaken.

In the UK Government report on engagement with new technology by older travellers [66], ideas were proposed that related to a smart user interface that could enable travelling. However, several researchers have commented that older people have a long list of needs that would be important for their travelling, for example the availability of rest places, toilet facilities and ease of access and egress at all points. Whilst Transport for London [TfL] has gone a long way in enabling wheelchairs on buses and other travel places, this is clearly not a completed exercise as for example many tube stations remain wheelchair-unfriendly and information about when the next bus is arriving is not sufficient to enable trouble-free travelling; nor with much lower levels of per capita spending on transport outside of London, are things looking as good.

The report [66] also proposed that big data and information being provided by users can work towards the data base needed so that the full panoply of needed information is accurate, precise to what is needed and provided in real time for older and less physically able travellers. As an example, you as a disabled might want to go on a journey to eat a meal at a restaurant with your friends, calling on the way back to collect some items from [say] the chemist. The information you will need includes the transport availability, estimated arrival time, whether or not you will be able to board, the availability of facilities at the destination stop, the availability of ramps, or stairs, or seating, whether under cover, etc. at the destination. Then all the same information to get to the next destination, the chemist, then more information again about the homeward part of the journey. You also need to be fairly certain that the service will actually be running with no cancellations, no temporary movement of stops, for all three journeys. In the world of totally personalisable transport, you would be able to book the whole journey using a personalized vehicle from start to destination to destination to home, and do all this booking by touchscreen.

So the question is- where are we in relation to the ideal world of reliable transport, full information provided in real time, integration of services, etc. And further, can all this be achieved using a full blown Maas? And if so, how will this work in rural and small-town environments as opposed to large cities, particularly London, where there is already some integration?

It has been argued by many authors that this requires a political will, some legislation, and planning and infrastructure changes to get there. The recent massive changes to cycling infrastructure following from making transport more Covid-compliant has actually, at the time of writing, moved people out of buses and into cars and some onto cycles. The Cycle superhighways in London are certainly reducing road space for other vehicles; the congestion charging there has also changed how traffic is operating. However these are somewhat piecemeal and need to be even more integrated, which is possible of course, but so far at a much larger expenditure rate [in London] than for any other region or city in the country. We still see bus stops moved temporarily, and other issues that make a journey for a disabled person much more hazardous and difficult.

The UK government has also reported on what a future might be like for more active modes of travel, including walking of course but also electric bikes, scooters, and e-boards. The possibility for electric bikes and scooters is that they will bring more, and older, women into travelling and possibly leaving their cars behind especially for shorter journeys. The evidence is that shorter journeys dominate car use in cities and towns in the UK and elsewhere, and ebikes that can take cargo offer the possibility of local shopping in a more environmentally friendly, healthier and more sustainable way; however these also require some infrastructure changes to ensure they are as safe as possible, for example cycling highways and safe and secure parking (as things such as batteries are valuable) [67]. Ebikes are also likely to require legislation since at the moment they can go quite fast with an unlicensed driver, such as a 70 year old woman who does not hold any driving license can buy and drive one of these.

The problem is however more complicated, as many of these solutions suit shorter journeys, especially in better weather conditions and necessitate their own infrastructure. On top of that, there is how we address longer journeys- so city to city, from 20 to 30 right up to 500–600 miles. In addition to this, there is the need for MaaS for the older traveller who cannot drive or walk with any ease, and who, as we have seen, might have memory problems and need logistical support and real time information to enable the journey.

4. The needs of the older traveller

There are several major over-arching issues here, from which all the requirements may be derived, and these issues are:

- There are design features that are absolutely necessary for older people but which can benefit all users.
- That the primary way forward, especially for older users of transport, will be personalised and bespoke use of technology - for transport, assisted living, health etc., all designed in a user-centred and participatory way.
- That there is always going to be a 'tech-savvy' divide, for at least several decades into the future; therefore it is *not* proposed here that we try to increase 'tech-savviness' as such but adapt the technology instead.
- Using new technology is never going to be intuitive to people on the lower levels of tech-savviness unless it's design is specifically targeted for that level of user.

4.1 Design features that deter users

There are already many examples of what constitute 'good' and 'poor' features from an ergonomic perspective, and to this we can also add design principles and what research on technology acceptance is telling us. Examples of technology design featured include the following with comments about why each may deter users:

- Poorly designed keypads. A major problem for old people particularly is that keypads of some digital devices are too small for accurate operation.

- Complex interfaces. Complexity may introduce errors and slow them down. If the interface has jargon and unfamiliar symbols as well as too many choices, this will put off many people. Perceived ease of use as well as perceived usefulness are critical in technology acceptance.

- Counter-intuitive or difficult navigation. Today's older people were born and grew up in the analogue, not binary, world. For a digital interface to be intuitive to them, the design proposition must come from their more analogue-oriented point of view. "Users often leave web pages in 10-20 seconds if they do not see a clear value" [68]. Features like flashing and alternating pictures that make websites aesthetically pleasing are often at a cost of usability.

- Over-functionality. 'Design for design's sake': the evidence shows that on many products there is more functionality than most people ever need.

- Lack of support in relation to technical issues. Many older people are dependent on a friend or relative to help in set-up and support; without these, many more older people would become lapsed users. In addition, for technologies purchased for the long term, there is also a concern associated with 'upgrades'.

- Trust and belief. Not meeting current needs leads to sceptical views on being unlikely to meet any needs as yet unidentified.

4.1.1 Features of good design

One of the most cited 'good' technology examples is the iPad. From the ergonomic and design perspectives, iPad and other 'good' designs have all or most of the following features:

- Natural and intuitive navigation and transaction with a clear and consistent structure such that related things are together;

- Simple to use for easy and common tasks in plain language;

- Straightforward visualisation or complexity is not at all evident;

- Embedded reversibility and tolerance principle to allow easy corrections through *undo* and *redo*;

- Large keypad or touchpoints to avoid making errors;

- Visible options without distraction;

- Built-in feedback available so the user is informed of actions or changes;

- Tolerating varied inputs and sequences; and

- Maintaining consistency with purpose so the user does not have to rethink and remember.

The 'good' technology can encourage engagement as it offers independence, allows the user to understand what they are doing and the needs it will meet. It does not require any special expertise or skills and its navigation elements are completely clear. Evidence is pointing towards some new technologies being poorly designed and not meeting many of these criteria, thus making them distinctly unattractive to older people. There are lessons here for all design of technology.

4.1.2 Inclusive design and Norman's principles

Inclusive Design is based on an explicit understanding of users, tasks, and environments, who are involved throughout the design and development stages. User-centred evaluation drives and refines the design (e.g. Kansei engineering); and the process is iterative, i.e. design-prototype-test-modify repeated.

In addition, design must take into account Norman's [69] main principles:

- Visibility – the technology must show its functions to the user, "if instruction is needed the design has failed".
- Conceptual models – the designer's model of how the user perceives the operation of the device or technology, if there is none, we make up our own.
- Mapping – relationship between the controls and the resulting effects.
- Feedback – showing the effect of every action: is the effect immediately obvious? Visual is not enough may need auditory.
- Affordance – appropriate actions, provide clues to how the technology is operated, and define how it will be used.
- Constraints – lead to inappropriate actions, difficult to use, choices constrained.

4.1.3 Engaging older people with new technology.

Engaging older people with new and emerging technologies is fundamental. As the proportion of older people grows, there will be a concomitant increase in those people with functional decline, who will have specific needs at a personal level. People with mild but undiagnosed dementia will have different needs to those with some physical incapacities. We need to establish the design parameters of how technology can be bespoke and easily operationalised to meet user needs. For example, algorithms can and should be developed to take the user towards those functions they need and to direct them away from what they do not want or need, thus reducing over-functionality- a much-cited dis-benefit of technology. A particular and potentially problematic issue for design is that solutions for one disability may present problems for another. Only inclusive, user-centred and participatory design can respond to this challenge and has the additional benefit in designing services and products usable by those with the lowest tech-savviness.

What needs to **change** is the way the design process works, involving older people on an inclusive basis, with consultative teams of older people with mixed levels of tech-savviness to ascertain the types and depths of need, the prototypes developed for trial uses, with feedback and a repeated iterative process until the older users are content. Every Government should produce a Code of Practice relating to the design of technology being user-centred to promote simple, intuitive, adaptable and possibly adaptive human machine interactions to meet individual users' needs.

4.2 Personalised and bespoke travelling

"Inclusive travel" means that a trip is door-to-door, usually undertaken by a variety of modes including active ones and usable by everyone. The trip-maker requires knowledge of travel mode changes, parking, walking distance, accessibility at interchanges, facilities at various points in the trip (e.g. for meals, toilets, seating, escalator or lift), what to do in case of disruption, and details of destinations. The key hurdles on a trip include physical access/egress barriers, lack of accessible real-time trip information, route mapping, affordable and accessible technology, availability and reliability of support, and reliable multi-operator trip information.

However no 'seamless' or inclusive multi-modal travel is going to happen until all travel-related data are opened up, from both private and public sectors alike. This includes not only operational data, capacities and on board and in-situ facilities, but also information on:

- Accessibility at all levels including road surfaces, curbs, ramps, cycle lanes, walking distances, ticketing, boarding, alighting, resting places, parking and on-board seating availabilities, reservation choices, and access to facilities, etc.;

- Safety and comfort including access to support, flexible pedestrian/cyclist crossing times, road priority, visibility of vulnerable road users, detailed descriptions of spaces, seats and facilities, smart ticketing, etc.; and

- Costs and payment channels and methods.

This list is not exhaustive and more can be added, which leads to the need for new forms of data becoming increasingly available and integrated. "Citizen data", coming from individual users, can provide ratings, reviews, updates on current status and even personal information. This can help travellers in selection and use of services and products; it can also help service and operation providers, designers and developers to identify accessibility gaps, shortcomings and improvements. Examples of how citizen data are obtained currently include social media, apps and blogs, whereby citizens add information that will be of use to other people.

4.2.1 Intelligent mobility

The Internet of Things (IoT) has the potential to embed the smartness into everyday objects and enable them to send and receive data. Infrastructure underpinned by IoT will make it possible for open data to be fully employed for the future of intelligent mobility.

Intelligent mobility needs to be considered in terms of not only the technology and the solutions to problems such as congestion, pollution and even the "lack of joined up thinking" between different means of travel, but also the focus on users. Psychological issues of users need to be addressed if intelligent mobility is to work, understanding particularly the different needs and preferences represented by the increasing numbers of over 85 yrs. Autonomous vehicles (AVs) operating door-to-door, One-to-X user(s) and demand-responsive transport services could present a better solution for this group than trying to help them undertake multi-mode trips.

MaaS is perhaps most relevant to those aged 85 + yrs., especially those who may be more vulnerable, live alone or are potentially isolated and may be 'dependent passengers' and thus are likely to be those needing a personalised service. However this appears to present the greatest challenge in MaaS. These people can be early adopters once transport policy is changed to facilitate the development of personalised travel. A place to start might be the full integration of patient and health/hospital transport without it taking 9 hours to get people back home and this could then be extended, for example, to include shopping.

Transport operators, network providers and local and national governments are among the many stakeholders and there are indeed many beneficiaries, not just older people. However it has many challenges, including opening up of all travel and user data, both public and private, identifying physical and information gaps in the detail necessary to allow access and egress. There is a need to integrate accessibility-related travel and destination information into personalised travel information necessary to maximise mobility; the information needs to be e more intuitive and creative in its presentation.

We also need to redefine future public transport. With the rise of AVs and other advanced technologies, future changes such as car ownership and dependency must be anticipated in a world where there is a great uncertainty in future mobility patterns.

4.3 Adapting technology to suit all users including the 'not tech-savvy'

Most technologies are not designed with older people in mind. Designers need to understand the criteria that people use to discriminate "good" from "bad" design of technology, consider the actual meaning of utility and relevance (of products, devices) to older users. The development and implementation of freely accessible 'learning' apps and websites that provide location details, images and dimension details to enable real and accurate travel choices to be made for use on both personal devices and in-situ guides is important and can make good use of Citizen data, if only this can be opened up, as mentioned above.

4.3.1 The role of 'nudge'

So long as technology continues to develop, there will always be varying levels of tech-savviness However changing and improving access and mobility in relation to transport does not need to involve making people more 'tech-savvy': we can achieve small behaviour changes by using the behavioural economics concept of 'nudging' [70], which means that new technology must appear, to *ALL* people who are non-tech-savvy, to be working in ways they already recognise, see as easy to use and as useful. Some of the 'nudges' include:

- Start from the base of 'good technology' i.e. devices most people have or may be familiar with, e.g. iPad or similar, that can then be used as a platform for further new developments and apps.

- Encourage people by using their own cohort: for example technology suppliers and services providers could increase the presence of older staff at public transport interchanges.

- Run regular attitude and behaviour change campaigns that nudge by focusing on already identified user needs and likely future needs.

- Invest in innovative and creative forms of human machine interactions in terms of 'learning' functions and accessibility of current 'help' functions for older travellers and ascertain the best methods to improve confidence through use.

- Produce a guide for the physical design attributes of display and control features, especially applicable to those in close geographical areas where all relevant information, such as on-board, interchanges, stops and stations, can be shared; this relates also to 'learning apps' mentioned above.

4.3.2 Ergonomic design features

Many people will get slower, their working memory will decline, they will have more problems with divided attention but they may still want to do many or all the things they used to, and technology can be a major part of that. A lot of good ergonomic knowledge exists but does not often seem to permeate into good or appropriate design, and so there is a list of ergonomic and design features that remain problematic and should be addressed:

- Technology must present in a way that focuses on memory support, allowing for actions made to be reversed and contain sufficient appropriate prompts.

- Algorithms and systems within new technology must be developed that allows users to find the relevant information and not be distracted by irrelevant or unneeded instructions or information. Either that or the technology should be a lot less complex.

- The technology should contain the option to look at previous successful behaviours to aid those with memory problems.

- Over-functionality swamping the usual usage. It may intimidate users with low skill levels. There is a variety of good pictorial style algorithms that do not appear to be used.

- Integrated technology has mixed potential: to be a wonderful game-changer but also complex, difficult to understand and threatening control or independence. We need to understand how older people may choose to disengage and engage with it, when and why.

4.3.3 Some solutions are here now, if we choose to introduce them

Addressing many of the points identified will take time as they require significant additional work, changes in behaviour or amendments to legislation. However there are a number of issues where solutions and improvements seem to be readily available or just require minor changes to current material and legislation:

- More larger and ergonomic displays with touchscreen technology for journeys and destinations, e.g. transport interchanges and stations.

- Make it easy and simple to interact with technology in every day behaviour and in public areas or with public services, so that it does not deter people whether tech-savvy or not.

- Assess support systems in terms of their responsiveness and ease of use and understanding: we already have the knowledge to produce better designed instruction and manuals. Help in "setting up" and operating computers is needed and help services should avoid scripted answers that deter users.

- Make personalised and self-paced learning available when introducing new technologies.

- Provide 'senior' preference settings (e.g. larger pictograms, simpler buttons, reduced complexity) and simplified navigation

- Enabling more personalization of over-functional complex controls on interfaces.

5. Conclusions

We know that as we get older, several cognitive and other psychological aspects decline and a few others improve. In addition there are sometimes other deteriorations of which we may be unaware such as decline due to illness. In addition, there will be more and more both able bodied and incapacitated people for the next two decades, at least in most countries.

These things all put increasing requirements onto transport of all kinds. In addition, psychologically, people like their own space in transport, so the future must allow for both public and private means of transport and must be increasingly accessible if older travellers are to engage.

The future will not be the same as at present, nor will it necessarily be a modified version of the present. For certain, we will see electric vehicles of all types, and may also see as many or even more vehicles than at present. The problem of vehicle emissions will largely go away, and within two decades in most developed countries. There will be AVs in increasing numbers that essentially must be adaptive to humans in control of other vehicles. Public transport will use Big Data and IoT such that individual travellers can link their own information and convenience needs to the transport availability and will use simple and easy apps on iPad-type devices and eventually wearable devices. For older people, there has to be a full development of MaaS so that personalisable public transport is available for those choosing not to own a programmable AV of their own, or for those no longer able to drive but who seek independence.

Author details

Joan Harvey[1,2]

1 Newcastle University, United Kingdom

2 Czech University of Life Sciences, Czech Republic

*Address all correspondence to: joan.harvey@ncl.ac.uk

References

[1] OECD (2016), Skills Matter: Further Results from the Survey of Adult Skills. OECD Skills Studies, OECD Publishing, Paris, France

[2] Craik, FIM and Salthouse, TA (2000). The handbook of aging and cognition. Hillsdale, NJ: Erlbaum.

[3] Park DC and Schwartz N (2012) Cognitive Aging: A Primer. Psychology Press Hove, East Sussex.

[4] Baltes, P. B., Staudinger, U. M., & Lindenberger, U. (1999). Lifespan psychology: Theory and application to intellectual functioning. Annual Reviews of Psychology, 50, 471-507.

[5] Reuter-Lorenz PA and Lustig C (2005) Brain aging: reorganizing discoveries about the aging mind. Current Opinion in Neurobiology. Vol 15(2): 245-251

[6] Reuter-Lorenz, PA and Cappell, KA (2008). Neurocognitive aging and the compensation hypothesis. Current Directions in Psychological Science, 17, 177.

[7] Lesch MF and Hancock PA (2004) Driving performance during concurrent cell-phone use: are drivers aware of their performance decrements? Accident Analysis and Prevention Vol 36(3): 471-480

[8] Ball, K.et al. (1998) 'Driving avoidance and functional impairment in older drivers', Accident Analysis & Prevention, 30(3), pp. 313-322.

[9] Rosenberg, L, Kottorp, A, Winblad, B and Nygård, L (2009). Perceived difficulty in everyday technology use among older adults with or without cognitive deficits. Scandinavian Journal of Occupational Therapy, 16(4), pp216-226

[10] Nygård, L and Kottorp, A (2014). Engagement in instrumental activities of daily living, social activities, and use of everyday technology in older adults with and without cognitive impairment. The British Journal of Occupational Therapy, 77(11). bjo.sagepub.com

[11] Carlson, MC, Erickson, KI, Kramer, AF, Voss, MW, Bolea, N, Mielke, M, Fried, LP (2009). Evidence for neurocognitive plasticity in at-risk older adults: The experience corps program. Journal of Gerontology A: Biological Sciences and Medical Sciences, 64, 1275-1282.

[12] DfT (2019) National Travel Survey: 2019 . Personal travel statistics within Great Britain covering English residents. URLs: https://www.gov.uk/government/statistics/national-travel-survey-2019, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/906847/nts-2019-factsheets.pdf, https://www.gov.uk/government/statistical-data-sets/nts08-availability-and-distance-from-key-local-services

[13] Bolstad C A (2001) Situation awareness: does it change with age? Proceedings of the Human Factors and Ergonomics Society Annual General Meeting. Vol 45(4): 272-276.

[14] Head D and Isam M (2010) Age effects on wayfinding and route learning skills Behavioural Brain Research. Vol 209(1): 49-58

[15] Moffat SD, Zonderman AB and Resnick SM (2001) Age differences in spatial memory in a virtual environment navigation task. Neorobiology of Aging. Vol 22(5): 787-796

[16] Fisher GH (1968) *The Frameworks for Perceptual Localisation*. University of Newcastle Upon Tyne

[17] Laflamme L and Menckel E (1995) Aging and occupational accidents a review of the literature of the last three decades Safety Science Vol 21(2): 145-161

[18] Charlton JL, Oxley J, Fildes B, Oxley P, Newstead S, Koppel S, O'Hare M (2006). 'Characteristics of older drivers who adopt self-regulatory driving behaviours', Transportation Research Part F: Traffic Psychology and Behaviour, 9(5), pp. 363-373.

[19] Davidse, R.J. (2006) 'OLDER DRIVERS AND ADAS: Which Systems Improve Road Safety?', IATSS Research, 30(1), pp. 6-20.

[20] DC and Hedden T (2001) Working memory and Aging. In Naveh-Benjamin, M Moscovitch and HL Roediger III *Perspectives on Human Memory and Cognitive Aging: Essays in honour of Fergus Craik*. Pp 148-160.

[21] Healey, MK, Campbell, KL and Hasher, L (2008). Cognitive aging and increased distractibility: Costs and potential benefits. Progress in Brain Research, 169, 353-363

[22] Kane, M. J., & Engle, R. W. (2000). Working-memory capacity, proactive interference, and divided attention: Limits on long-term memory retrieval. Journal of Experimental Psychology. Learning, Memory, and Cognition, 26, 336-358.

[23] Pangbourne, K., Aditjandra, P.T., Nelson, J.D. (2010). New technology and quality of life for older people: exploring health and transport dimensions in the UK context. IET Intelligent Transport Systems, 4(4), December 2010, pp318-327. IET.

[24] Leung, R (2009). Improving the learnability of mobile device applications for older adults. Proc. CHI '09 Extended Abstracts on Human Factors in Computing Systems, pp3125-3128. 4-9 Boston, Mass

[25] Tuzlukov VP (2001) Signal Detection Theory. Springer Science New York.

[26] Brouwer WH, Waterink W, Van Woffelaar PC and Rothengatter T (1991, online 2013) Divided attention in experienced young and older drivers: lane tracking and visual analysis in a dynamic driving simulator. Human Factors: the Journal of the Human Factors and Ergonomics Society. Vol 32(5): 573-582.

[27] Pauzie, A, Bathsavanis, A and Hamama, H (2010). Elderly travelers interacting with mobile phone for public transport service: human centred design issues. Applied Human Factors and Ergonomics Conf., Miami, USA.

[28] Nicholson N (2001) *Managing the Human Animal*. Crown Business, New York

[29] Cacioppo JT, Petty RE, Kao CF and Rodriguez R (1986) Central and peripheral routes to persuasion: An individual difference perspective. Journal of Personality and Social Psychology Vol 51(5); 1032-43.

[30] Czala SJ and Sharit J (1998) Age Differences in Attitudes Toward Computers. The Journal of Gerontology. Series B, Psychological Sciences and Social Sciences 1998 Sep;53(5):329-P340.

[31] Rick, T (2011). Top 12 Reasons why People rest Change. Change Management May 23rd edition. URL: https://www.torbenrick.eu/blog/change-management/12-reasons-why-people-resist-change/ (accessed on 7 Jan 2017).

[32] Rhodes N and Pivik K (2011) Age and gender differences in risky

driving: The roles of positive affect and risk perception. Accident Analysis & Prevention Vol 43(3): 923-931.

[33] Harvey J, Heslop S and Thorpe N (2011) The categorization of drivers in relation to boredom. Transportation Planning and Technology Vol 34(1): 51-69

[34] Scialfa, T, Kline, DW and Lyman, BJ (1987). Age differences in target identification as a function of retinal location and noise level: Examination of the useful field of view Psychology and Aging, Vol 2(1)14-19.

[35] Jette, A.M. and Branch, L.G. (1992). A ten-year follow-up of driving patterns among the community-dwelling elderly, Human Factors: The Journal of the Human Factors and Ergonomics Society, 34(1), pp. 25-31.

[36] Marottoli, R.A.et al. (1997) 'Driving cessation and increased depressive symptoms: Prospective evidence from the New Haven EPESE', Journal of the American Geriatrics Society, 45(2), pp. 202-206.

[37] Musselwhite, CBA and Haddad, H (2010). 'Mobility, accessibility and quality of later life', Quality in Ageing and Older Adults, 11(1), pp. 25-37.

[38] Musselwhite, C. (2011) 'The importance of driving for older people and how the pain of driving cessation can be reduced', Journal of Dementia and Mental Health, 15(3), pp. 22-26.

[39] Eby, DW and Molnar, LJ (2012). 'Has the time come for older driver vehicle?'. https://deepblue.lib.umich.edu/bitstream/handle/2027.42/89960/102821.pdf (accessed on 7 October 2016).

[40] Finucane, M.L.; Alhakami, A.; Slovic, P.; Johnson, S.M. (2000) The Affect Heuristic in Judgment of Risks and Benefits. Journal of Behavioral Decision Making 13 (1): 1-17

[41] Harvey J, Thorpe N and Fairchild R (2013) Attitudes towards and perceptions of eco-driving and the role of feedback systems. Ergonomics Vol 56(3): 507-521

[42] Matthews ML and Moran AR (1986) Age differences in male drivers' perception of accident risk: The role of perceived driving ability. Accident Analysis and Prevention Vol 18(4): 299-313.

[43] McGwin Jr G and Brown DB (1999) Characteristics of traffic crashes among young, middle-aged and older drivers. Accident Analysis and Prevention. Vol 35(3): 181-198

[44] Colcombe, S. J., Erickson, K. I., Scalf, P. E., Kim, J. S., Prakash, R., McAuley, E., Kramer, A. F. (2006). Aerobic exercise training increases brain volume in aging humans. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 61, 1166-1170.

[45] Gordon, BA, Rykhlevskaia, E, Brumback, CR, Lee, Y, Elavsky, S, Konopack, JF and Fabiani, M (2008). Anatomical correlates of aging, pulmonary fitness level, and education. Psychophysiology, 45, 825-838.

[46] Heart, T and Kalderon, E (2013). Older adults: are they ready to adopt health-related ICT? International Journal of Medical Informatics, Vol. 82, Issue 11: 209-231,. Elsevier

[47] Hanson, V.L. (2009). *Age and web access: the next generation*. In: Proceedings of W4A, Madrid, Spain, April 20-21, pp. 7-15. ACM, New York

[48] Trewin, S., Richards, J., Bellamy, R., John, B.E., Swart, C., Sloan, D.

(2011). Extending predictive models of exploratory behavior to broader populations. In: Stephanidis, C. (ed.) Proceedings of HCI International, LNCS, Vol. 6765, pp. 152-161. Springer, Heidelberg.

[49] Vines, J, Pritchard, G, Wright, P, Olivier, P and Brittain, K. (2015). An age-old problem: examining the discourses of ageing in HCI and strategies for future research. ACM Transactions on Computer-Human Interaction (TOCHI), 22(1), Feb. 2015. DOI: http://dx.doi.org/10.1145/2696867.

[50] Page, T. (2014). Touchscreen mobile devices and older adults: a usability study *International Journal of Human Factors and Ergonomics*, 3(1).

[51] Sochor, J. and Nikitas, A. (2016). Vulnerable users' perceptions of transport technologies, Proceedings of the Institution of Civil Engineers, 169(3), pp154-162.

[52] Selwyn, N. (2004). The information aged: A qualitative study of older adults' use of information and communications technology, Journal of Ageing Studies, 18 (4), 369-84.

[53] Barnard, Y., Bradley, M.D., Hodgson, F., Lloyd, A.D. (2013). Learning to use new technologies by older adults: perceived difficulties, experimentation behaviour and usability. Computers in Human behavior, 29(4): 1715-1724. Elsevier.

[54] ONS (2020) Internet access – households and individuals, Great Britain: 2020. https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/bulletins/internetaccesshouseholdsandindividuals/2020

[55] Damant, J and Knapp, M (2015). What are the likely changes in society and technology which will impact upon the ability of older adults to maintain social (extra-familial) networks of support now, in 2025 and in 2040? Future of ageing: evidence review, Government Office for Science, UK, London, UK, August 2015

[56] Mitzner, T.L., Boron, J.B., Fausset, C.B., Adams, A.E., Charness, N., Czaja, S.J., Dijkstra, K., Fisk, A.D., Rogers, W.A., Sharit, J. (2010). Older adults talk technology: technology usage and attitudes Computers in Human Behavior Volume 26, Issue 6: 1710-1721 http://dx.doi.org/10.1016/j.chb.2010.06.020

[57] Rashidi, P., Mihailidis, A. (2013). A survey on ambient-assisted living tools for older adults. IEEE Journal of Biomedical and Health Informatics, 17(3), pp 579-590. IEEE

[58] Ofcom (2020) Adults' Media Use & Attitudes report 2020. https://www.ofcom.org.uk/__data/assets/pdf_file/0031/196375/adults-media-use-and-attitudes-2020-report.pdf

[59] Conway ARA, Jarrold CE, Kane MJ, Miyake A and Towse JN (2007). Variation in working memory. Oxford University Press. Oxford.

[60] Jaeggi SM, Buschkuehi M, Jonides J and Perrig W (2008). IM proving fluid intelligence with training on working memory. Proceedings of the National Academy of Sciences of the United States of America Vol 105(19): 6829-6833.

[61] Sternberg R (2008) Increasing fluid intelligence is possible after all. *Proceedings of the National Academy of Science* May 13 Vol 105 (19): 6791-92

[62] Hartley, J (1999). What does it say? text design, medical information and older readers. In [eds] DC Park, RW Morrell and K Shifren: *Processing of Medical Information in Aging*

Patients: Cognitive and Human Factors Perspectives. Chapter 14: 257-272.

[63] Hartley KW (2006) Media Overload in Instructional Web Pages and the Impact on Learning. *Educational Media International*. Vol 36(2): 145-150

[64] Wilkinson CR and De Angeli A (2014) Applying user centred and participatory design approaches to commercial product development. Design Studies Vol 35 (6): 614-631

[65] TSC (Transport Systems Catapult) (2016) Mobility as a Service: exploring the opportunity for mobility as a service in the UK. URL: https://ts.catapult.org.uk/wp-content/uploads/2016/07/Mobility-as-a-Service_Exploring-the-Opportunity-for-MaaS-in-the-UK-Web.pdf (accessed on 5 December 2016).

[66] Guo W, Harvey J, Edwards S. (2017) Older Travellers and Technology Engagement. Transport Systems Catapult, DfT London

[67] Harvey J & Guo A (2018). *Cycling and other active modes in the UK: how and why are they changing?* London: Government Office for Science.

[68] Tullis TS (2005) *Web-based Presentation of Information: The Top Ten Mistakes and Why They Are Mistakes.* HCI International conference, Las Vegas. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.107.9769&rep=rep1&type=pdf

[69] Norman D (2013) *The Design of Everyday Things*. [revised and expanded]. New York Basic Books

[70] Berry, G (2011). Can older drivers be nudged? RAC Foundation February 2011. URL: http://www.racfoundation.org/assets/rac_foundation/content/downloadables/older_drivers_nudge-main_report-berry.pdf