

Changes in wayfinding ability with age: use of wayfinding methods and attitudes towards GPSBryden, K. J.¹, Charlton, J.², Oxley, J.², Lowndes, G.¹¹School of Psychology and Psychiatry, Monash University;²Monash University Accident Research Centre (MUARC)

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Abstract

Driving to an unfamiliar location is one of the most difficult driving situations a motorist can face. Furthermore, potential age-related declines in cognitive abilities such as attention and processing speed may make wayfinding while driving even more challenging for some older drivers.

A survey of 536 drivers over the age of 65 was conducted to understand more fully the methods used and attitudes to new technologies. Over half of respondents reported some wayfinding difficulty. People who reported more difficulty with wayfinding tended to be older and reported poorer health and cognitive abilities. Drivers who reported poorer wayfinding abilities were more likely to rely on passengers, ask for directions on-route and pull over. Difficulties with wayfinding did not affect future use of GPS or attitudes towards the cost, safety and navigation effectiveness of GPS.

The results confirm that wayfinding is a challenging driving task for many drivers over the age of 65 and provide insight into the types of strategies utilised by drivers to assist with wayfinding.

Keywords

Older drivers, Wayfinding, GPS, Vehicle technology, Safety

Introduction

Some older drivers report difficulties with wayfinding while driving in unfamiliar areas [1-2]. Wayfinding can be defined as the cognitive and behavioural steps involved in reaching a destination [3]. When wayfinding in unfamiliar areas, a driver must interpret a map or directions in the context of the environment and make reasoned judgments about when to turn. These components of wayfinding place extra demands on cognitive resources compared to driving in familiar areas, which may lead to reduced driving safety and mobility. The purpose of this study was to gain more information about older drivers who report difficulties wayfinding in unfamiliar areas, focusing on attitudes to and the likely use of GPS amongst this group.

Most models of wayfinding in unfamiliar areas comprise three main elements: planning a route, seeking information from the environment and making a decision to execute each turn [3-5]. The planning phase involves an outline of the turns to be taken during the drive [3, 5], which requires organisation, problem solving, memory and visuospatial skills (if using a map). Seeking information from the environment enables the driver to determine where they are on the route [3, 5] and this requires good attention abilities, particularly selective and divided attention skills.

The driver must then use these two sources of information to make a decision about whether it is appropriate to turn or not [3, 5]. This requires intact visuospatial ability, to be able to correctly compare the environment to the planned route. Making the decision is straightforward if the information available clearly relates to the plan (e.g. a clear sign indicating the turn street). However, it can also require complex reasoning processes if the information is unclear and the decision about where the driver is on the route has to be inferred from multiple sources of information [5]. Searching for information and deciding where to turn must also be done under time pressure and while multitasking.

Models of wayfinding in unfamiliar areas suggest that it is a high level driving skill that some drivers may struggle with, particularly those with attention, processing speed, visuospatial memory or problem solving difficulties.

Given that normal ageing is associated with neurological change and cognitive decline on some neuropsychological tasks [6] that may be associated with wayfinding abilities, it stands to reason that

some older drivers will experience difficulty driving in unfamiliar areas, which may in turn increase crash risk and/or affect overall mobility.

The literature shows that cognitive skills decline with age, most consistently processing speed [6-8], but also the ability to form new memories [6-7], divided attention [9] and reasoning ability [8]. However, there is much variability in both the extent and rate of cognitive decline associated with ageing [7].

It is unclear at this stage whether older drivers, in general, experience difficulty with wayfinding, or whether it is only a sub-set of older drivers, especially those with declines in some health and cognitive abilities, who may have difficulty. While a number of studies suggest that older drivers increase their use of passengers to help them when wayfinding in unfamiliar areas [1-2], previous studies have some limitations including small samples and use of qualitative methods such as focus groups and in-person interviews.

An experimental study by Mallon and Wood [10] found that older drivers had relatively more difficulty with self-directed driving (rather than instructor-directed) compared with younger drivers. There was also some evidence that cognitive abilities were related to wayfinding performance, however Mallon and Wood [10] used an aggregate measure which did not allow analysis of which particular cognitive abilities were more highly related to wayfinding performance.

The most comprehensive study of self-reported wayfinding ability was conducted in the UK by Burns [4, 11]. Burns found that older drivers reported poorer wayfinding abilities and increased avoidance of unfamiliar areas compared with younger drivers. However, it was unclear whether perceived wayfinding performance continued to progressively decline with age or whether the changes were between certain age groups only. Burns found that female drivers reported more difficulty wayfinding and avoided unfamiliar areas more often than male drivers. Burns also found that self-reported difficulty with wayfinding was related to reduced mobility.

One potentially effective solution to help older drivers with wayfinding difficulties is the use of GPS or in-vehicle navigation systems. These systems provide the driver with turn information, reducing the load on memory, attention and problem solving. However, use of GPS is still an extra task while driving, and therefore there is expected to be some extra load compared to normal driving. Because of this, there are some safety concerns associated with use of GPS by older drivers. Indeed, the evidence is not clear. On the one hand, there is some suggestion that older drivers are less safe when using GPS systems compared with younger drivers [12-13]. However, use of GPS has also been found to be safer and more effective than using a conventional paper map for older drivers [13]. Moreover, the potential mobility benefits afforded by navigation systems are yet to be examined. Further research is required before recommendations can be made about whether older drivers should use GPS when wayfinding.

Technology is more commonly becoming a part of our everyday life, and it is also important to know whether older drivers will accept GPS as a potential solution to wayfinding difficulties. In general older people are slower to take up new technology, not because of lack of interest but due to attitudes towards usability and usefulness of the technology [14]. Indeed, research has indicated that some older drivers are interested in trying GPS and that they find them helpful after using them [2]. More research is needed about the potential use of GPS and older drivers' attitudes towards the technology.

In summary, there is some evidence that older drivers have (or report) difficulty with wayfinding and that it limits their mobility. However it is unknown whether self-reported wayfinding continues to decline with increasing age, and whether poor health and cognitive difficulties are related to reduced wayfinding ability. There is also limited information about the type of wayfinding methods used by people who report difficulties. In particular, little is known about the acceptability of and attitudes towards GPS units.

The primary aim of the current study was to gain more information about older drivers who reported difficulties with wayfinding in unfamiliar areas. It was hypothesized that drivers who were older and reported poorer health and cognitive abilities would be more likely to report difficulties with wayfinding than younger, more healthy participants. It was also expected that females may be more likely to report more difficulties with wayfinding than males.

A secondary aim was to investigate methods used to help with wayfinding. Use of a variety of wayfinding methods was compared based on self-reported wayfinding skills, to determine whether drivers who reported poorer wayfinding skills were more or less likely to use each method than drivers who reported better wayfinding skills. Specific attention was paid to the use of GPS units as these may be an effective solution to assist drivers with poor wayfinding abilities. The study also investigated attitudes towards GPS and the likelihood or open-mindedness to using a GPS unit in the future.

Method

A questionnaire was mailed to 3,000 members of the Royal Automobile Club of Victoria (RACV) who were aged 65 years and over. The questionnaire included items on perceived wayfinding abilities, avoidance of unfamiliar areas, usefulness of methods used to assist driving in unfamiliar areas and use and attitudes towards GPS. General driving, demographic and health items were also included. The items required both open-ended and closed responses.

The sample for recruitment was randomly selected from the RACV membership database and stratified based on the age and residential location of the Victorian population to ensure a representative sample [15]. Responses were received from 18.6% of the mail-out (558 members); 22 were excluded as they did not meet inclusion criteria, had excessive missing data or were multivariate outliers.

Results

Sample demographics

Of the sample included for analysis ($n=536$ drivers), 64% were male. Responses were received from participants in a variety of age groups: 31% aged 65-69; 26% aged 70-74; 23% aged 75-79; and 20% aged 80 and over. The residential location of the sample was broadly consistent with the distribution of Victorians aged 65 and over (56% metropolitan Melbourne, 24% regional and 20% rural [15]). The majority of participants were married or in a de facto relationship (70%). The majority of participants had some secondary level education (53%) and a further 41% had post-secondary education. The majority of participants were the drivers on most or all of their driving trips (80%) and carried an adult passenger at least some of the time (98%).

Self-rated wayfinding abilities

Participants were asked to rate their wayfinding abilities in a number of driving situations on a three point scale (Poor, Fair, or Good). Very few participants reported any difficulties with wayfinding in familiar locations (93% reported their abilities as Good), while only 40% of people reported their ability to find their way in unfamiliar areas as Good (52% reported fair abilities). Even fewer participants reported "Good" wayfinding ability for wayfinding through an unfamiliar city or on an unfamiliar motorway (19% and 31%, respectively).

A series of Chi-Square analyses were undertaken to examine variables that may be associated with self-rated wayfinding abilities. The variable "driving to an unfamiliar location" was used for these analyses as this was considered to be a task that most drivers would perform more often than other driving situations related to wayfinding. In addition, for each of the analyses drivers who rated their abilities as Good were compared to those that rated their abilities as Fair or Poor (these were combined given only 7% of participants rated their wayfinding ability as Poor).

Age was associated with ratings of wayfinding abilities. Significantly more younger (aged between 65 and 74 years; 44.0%) than older drivers (aged over 75 years; 32.2%) rated their wayfinding as Good (rather than Fair/Poor), Pearson $\chi^2(1, N = 514) = 6.51, p=.01$, Cramer's $V = .11$. The probability of a respondent rating their wayfinding ability as Good was about 1.37 times more likely if the driver was younger (65-74 years) rather than older (75 years or older).

Forty-two percent of males rated their wayfinding as Good compared to 38% of females. This difference was not significant, Pearson $\chi^2(1, N = 513) = 0.97, p=.325$, Cramer's $V = .04$.

Self-reported health status was also associated with ratings of wayfinding abilities. Drivers were asked to rate their health using a five point scale (Very Poor, Poor, Fair, Good, Very Good). For this variable,

the lower three categories were combined, given few participants rated their health as Poor or Very Poor. The proportion of drivers who rated their wayfinding as Good is presented for each self-rated health grouping in Figure 1. Those who rated their health status as better were significantly more likely to rate their wayfinding as Good rather than Fair/Poor, Pearson $\chi^2(3, N = 496) = 24.7, p < .001$, Cramer's $V = .22$.

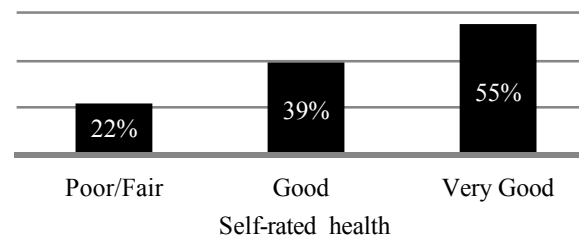


Figure 1. Self-rated good wayfinding skills by self-rated health

Follow-up pairwise comparisons were conducted to evaluate the difference among these proportions (shown in Table 1). The Bonferroni method was used to control for Type 1 error at the .05 level across all three comparisons. All three pairwise comparisons were significant. The probability of a respondent rating their wayfinding ability as “Good” was about 2.5 times more likely if the driver rated their health as Very Good rather than Poor/Fair.

Comparison (Health)	Pearson chi square	<i>P</i> value (Alpha=.017)	Cramer's <i>V</i>
Poor/Fair vs. Good	7.70	.006	.15
Good vs. Very Good	9.93	.006	.15
Poor/Fair vs. Very Good	22.56	<.001	.32

Table 1. Pairwise comparisons for self-rated wayfinding ability by self-rated health.

Self-rated wayfinding abilities were also examined relative to self-reported functional abilities. Participants were asked a series of questions about memory (five questions), attention (two questions) and planning (three questions) on separate five-point scales from Very Poor (0) to Very Good (4). Total scores for each function were calculated by averaging responses. For the t-tests, attention and planning scores were transformed using a logarithmic transformation to correct skewness.

Participants who rated their wayfinding ability as Good also rated their memory, planning and attention abilities as better than those who rated their wayfinding abilities as Poor/Fair. A series of independent samples t-tests confirmed that these differences were significant (see Table 2). However, the effect sizes were very small [16].

Dependent Variable	Mean (SD) rating for Good	Mean (SD) rating for Poor/Fair	T	<i>P</i> value (Alpha=.05)	Partial Eta Squared
Memory	3.08 (.58)	2.86 (.59)	-4.28	<0.001	.04
Attention	3.07 (.71)	2.84 (.81)	3.80	<0.001	.03
Planning	3.18 (.65)	2.93 (.71)	3.10	0.002	.02

Table 2. *t*-tests for self-rated wayfinding ability (Poor or Fair vs. Good) by self-rated cognitive abilities.

Use of different wayfinding methods

Use of wayfinding methods was investigated to determine which methods were more commonly used and to examine whether drivers with poorer self-rated wayfinding abilities were more likely to use different wayfinding methods than those with Good self-rated wayfinding ability.

Participants were asked to rate how often they used different wayfinding methods on a five point scale (Never, Rarely, Sometimes, Often or Always). The majority of participants reported that they used a street directory and/or pulled over Often or Always when finding their way (61.7% and 55.3%, respectively). Around a third of participants reported using their memory or following written

instructions (directions or map) Often or Always (37.8% and 33.5%, respectively). Using a passenger or asking for directions en-route was less common (24.2% and 18.0%, respectively), however almost one in ten participants reported using these strategies all the time while wayfinding. Very few participants reported using a navigation system Always or Often (9.8%), however 14.3% of participants reported using one at least some of the time.

Wayfinding ability was examined in relation to the use of wayfinding methods (Figure 2). A series of Chi-Square analyses confirmed that those who rated their wayfinding ability more poorly were significantly more likely to pull over to check directions, use a passenger to help them, and to ask for directions on-route compared with those who rated their ability more highly (Table 3). This group was also significantly less likely to rely on their memory to find their way.

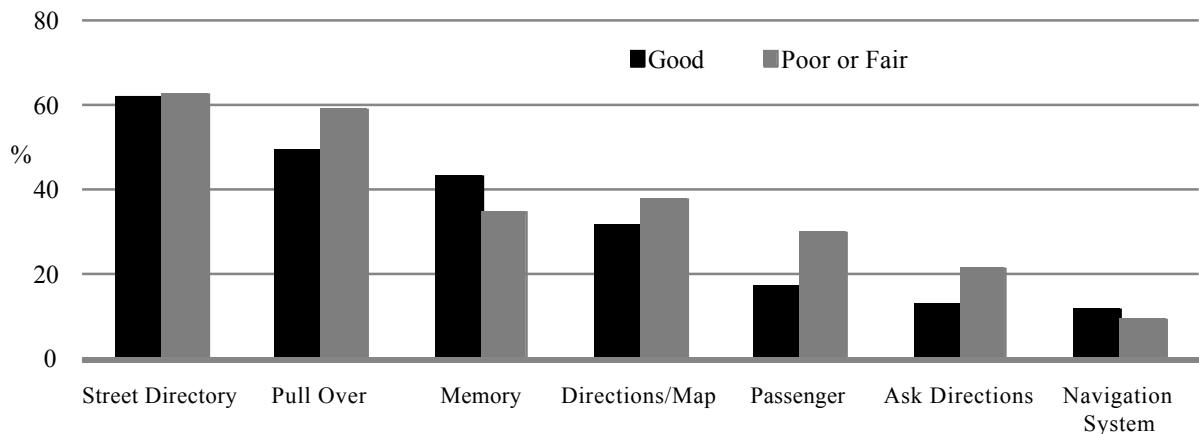


Figure 2. Proportion of drivers who use navigation methods Often or Always by self-rated wayfinding ability

Comparison	Pearson chi square	<i>P</i> value (Alpha=.05)	Cramer's V
Street directory	0.06	.815	.01
Pull over	4.69	.030	.10
Memory	4.02	.045	.09
Directions or Paper map	0.80	.371	.04
Passenger	10.88	.001	.15
Ask for directions (phone or in person)	6.84	.009	.11
In-vehicle navigation system	0.92	.337	.04

Table 3. Chi-Square tests for use of wayfinding methods (Often or Always) by self-rated wayfinding ability (Poor or Fair vs. Good)

Use of GPS units

Participants were asked a series of questions relating to their attitudes to and use of GPS units and these responses are presented here. First, participants were asked about their use of GPS units and only a small proportion of participants had used one (17.3%) and a smaller proportion (12.8%) currently owned one. Some additional analyses were conducted to understand the characteristics associated with use and ownership of GPS units. Amongst those who owned a GPS unit, younger drivers (aged 65-74 years) were significantly more likely to own a unit (19.0%) compared with older drivers (aged 75 years and over; 4.5%), Pearson $\chi^2(1, N = 529) = 24.11, p < .001$, Cramer's V = .21. No significant difference was found for self-rated wayfinding and ownership of GPS. Sixteen percent of those who rated their wayfinding as Good and 11.4% of those who rated their wayfinding as Fair or Poor owned a GPS unit, Pearson $\chi^2(1, N = 511) = 1.99, p = .158$, Cramer's V = .06.

Participants were also asked whether they would use a GPS unit in the future if one were available to them. Over 50% of the sample reported that they would be somewhat or very likely to use a system in the future (21.1% and 35.3%, respectively), while only 29.7% reported that they would be not very likely to use one (13.1% were unsure). No significant effects of age or self-rating wayfinding abilities were found for future use of GPS. Sixty-nine percent of younger participants aged 65-74 years and

60.0% of older participants were likely to use a GPS in the future, Pearson $\chi^2(2, N = 459) = 4.08$, $p=.130$, Cramer's $V = .09$. Likewise, 62.9% of those who rated their wayfinding as Good and 69.0% of those who rated their wayfinding as Fair or Poor were likely to use a GPS in the future, Pearson $\chi^2(2, N = 441) = 2.37$, $p=.306$, Cramer's $V = .07$.

A series of questions were asked to examine attitudes towards GPS units and each was measured on a 5 point scale (Agree Strongly to Disagree Strongly), however it is important to note that many participants did not have past experience with GPS units. Around half the participants agreed (Slightly or Strongly) that GPS units were too expensive (53%). Around 40% of participants were concerned about the distracting nature of GPS units (taking eyes of road for too long and general distraction, for each 44% agreed Slightly or Strongly). Around 40% of participants were concerned that the navigation unit might not direct them along the best possible route (41% agreed Slightly or Strongly). Likewise, approximately 40% of participants were unsure how GPS units worked and around one third thought it might be too complex (41% and 34% respectively, agreed Slightly or Strongly). Only around one in five participants agreed (Slightly or Strongly) that the GPS unit might take them in the wrong direction or not give enough warning before turns (21% and 20%, respectively).

As can be seen in Table 4 many attitudes towards GPS were similar for participants who reported their wayfinding as Poor or Fair compared to Good. However, participants who reported their wayfinding as Poor or Fair were significantly more likely to be unsure about how GPS worked and were more likely to consider GPS units too complex.

Comparison	% Poor or Fair	% Good	Pearson chi square	P value (Alpha=.05)	Cramer's V
Too Expensive	56	48	2.96	.085	.08
Too Distracting	46	41	1.12	.289	.05
Eyes Off the Road	46	41	0.83	.362	.04
Not Best Route	40	43	0.45	.504	.03
Unsure How Works	45	33	7.57	.006	.13
Too Complex	37	27	5.66	.017	.11
Take in Wrong Directions	23	18	1.65	.199	.06
Not Enough Warning	19	20	0.13	.723	.02

Table 4. Attitudes towards GPS (Agree Slightly or Strongly) by self-rated wayfinding ability (Poor or Fair vs. Good)

Discussion

Driving in unfamiliar areas is one of the noted difficulties for older drivers in the literature, however, little is known about the characteristics of those reporting difficulties, nor the methods used to assist driving in unfamiliar areas. This study has provided some new and important information about drivers over the age of sixty five who report difficulties wayfinding while driving in unfamiliar areas. The findings demonstrate that a relatively low proportion of older drivers (about two in five) consider themselves to have good wayfinding skills when driving in unfamiliar areas, with an even lower proportion reporting good skills when driving in unfamiliar cities or on unfamiliar motorways. In contrast, over nine out of ten drivers reported good wayfinding ability in familiar areas. This clearly demonstrates that wayfinding in unfamiliar areas is perceived by many older drivers as more difficult than driving in familiar areas.

The finding that drivers report their wayfinding as poorer with age was expected given previous research that self-reported wayfinding declines with age [4, 11]. Our finding adds to previous research by demonstrating that self-reported wayfinding continues to decline through older age. However, the cognitive and driving abilities of older drivers are extremely variable. It is possible that older drivers do not automatically have more difficulty with wayfinding; rather that older drivers are more likely to have health and cognitive difficulties which may impact wayfinding.

This is supported by the findings that drivers who reported poorer health and cognitive abilities also reported poorer wayfinding. This is also consistent with expectations, given that driving ability has been found to decline with lower levels of health. The extra cognitive abilities required for wayfinding suggest that people who have difficulty with attention, planning and memory would also have more

difficulty with wayfinding. However, it is important to note that both measures were subjective and therefore a proportion of this relationship may be attributable to negative or positive rating of abilities in general. Further research is being conducted to address this, objectively measuring cognitive abilities and comparing performance to wayfinding ability.

The finding that females did not report poorer wayfinding than males was not consistent with previous results. This was unexpected given the wording of the question was similar to Burns' [4, 11] study and the effect size found by Burns was similar to the effect size found for age. Further research into more objective measures of wayfinding may clarify whether there is an actual effect of gender on wayfinding difficulties.

One of the main aims of this study was also to understand more fully the methods commonly used to find destinations in unfamiliar areas amongst older drivers. The most commonly reported method amongst this sample of older drivers was the use of a street directory to help find their way in unfamiliar areas. Another common method was to pull over to check the destination. In general, methods which relied on the drivers' own skills were more popular than methods that relied on external sources to help guide them. Reliance on passengers, stopping to ask for directions and use of GPS units were less common.

Drivers who reported wayfinding difficulties were more likely to report using external sources of information (passengers and asking for directions). This is not surprising, given that these strategies can reduce the cognitive load on drivers. They were also more likely to pull over and check the map, which would allow them to fully attend to the wayfinding task and work at their own pace. Drivers who reported poorer wayfinding were also less likely to rely just on their memory for directions, which was expected given the extra cognitive demands of this method.

More specific questions about use of GPS units revealed that almost one in five drivers aged between 65 and 74 owned a GPS, while few drivers over the age of 75 owned one. Interestingly, however, there was no age difference in the proportion of drivers who indicated that they would use a GPS unit in the future if one were available to them. This indicates that other factors, such as cost, may influence an older driver's decision to buy a GPS unit, rather than older drivers being less interested in use of GPS than younger drivers. The results also indicated that current ownership and future use of GPS were not influenced by self-rated wayfinding ability. This suggests that people with perceived poorer wayfinding abilities may not be seeking out GPS to help them find their way, but also they do not appear averse to using the technology. More detailed research into the usability of GPS units by older drivers is required to determine whether they are a feasible solution for those with wayfinding difficulties.

Even though there was the suggestion that older drivers may not be averse to using GPS technology, there were some interesting findings regarding general attitudes towards the use of GPS units. Not surprisingly, around half of participants had concerns about cost. Interestingly, there were some noted concerns about safety (particularly distraction), navigation capabilities and useability of the units. Past research suggests that some older drivers have little awareness of vehicle technologies and safety features, and there is evidence of some misperceptions about some technologies, their safety benefits and useability [17]. Encouragingly, the current findings indicate that there are some general safety considerations regarding use of GPS units, particularly their effect on driving skill. However, it is important to note that many of these participants had not tried GPS units and further research is required to determine whether these attitudes reflect people's actual experiences with the units. One important finding was that those who reported their wayfinding as poor or fair were more likely to be concerned about the usability of the units, compared with those with higher ratings of wayfinding abilities. This may indicate an awareness among this group of their difficulties using new technologies. Moreover, this has some implications for the development of education and training programs for such technologies and that proper training and extra support may be particularly important for this group.

Conclusions

This study has identified some important factors associated with wayfinding difficulties in unfamiliar areas amongst older drivers. Age, poorer self-rated health and cognitive abilities were associated with poor ratings of wayfinding ability, as was avoidance of driving in unfamiliar areas and adoption of strategies to assist them such as use of passengers and asking for directions. Some new information

regarding methods used to assist driving in unfamiliar areas was highlighted, especially identification of attitudes to and use of GPS navigation units.

This new information has enhanced our understanding of the wayfinding abilities of older adults and some of the methods they use to compensate for the difficulties they experience. This information can be used to guide countermeasures to assist these older drivers to adopt appropriate strategies to maintain their safe mobility. Further research is required to add to these findings. Follow up studies are currently being conducted to determine whether self-reported wayfinding ability predicts actual wayfinding abilities and whether these abilities change with age, self-reported health and gender. Further research into the utilisation of GPS units by older drivers is also being conducted.

References

1. Vrkljan, B. and M. Polgar. *Driving safely in later life: Exploring the older driver-passenger relationship*. in *11th International Conference on Mobility and Transport for Elderly and Disabled Persons*. 2007. Montreal.
2. Kostyniuk, L.P., F.M. Streff, and D.W. Eby, *The older driver and navigation assistance systems*. 1997, The University of Michigan Transport Research Institute: Ann Arbor.
3. Passini, R., *Spatial representations, a wayfinding perspective*. *Journal of Environmental Psychology*, 1984. **4**: p. 153-164.
4. Burns, P.C., *Wayfinding errors while driving*. *Journal of Environmental Psychology*, 1998. **18**: p. 209-217.
5. Rainville, C., R. Passini, and N. Marchand, *A multiple case study of wayfinding in dementia of the Alzheimer type: Decision making*. *Aging, Neuropsychology and Cognition*, 2001. **8**(1): p. 54-71.
6. Hedden, T. and J.D.E. Gabrieli, *Insights into the ageing mind: A view from cognitive neuroscience*. *Nature reviews. Neuroscience*, 2004. **5**(2): p. 87-96.
7. Christensen, H., et al., *The Canberra longitudinal study: Design, aims, methodology, outcomes and recent empirical investigations*. *Aging, Neuropsychology and Cognition*, 2004. **11**(2-3): p. 169-195.
8. Salthouse, T., *What and when of cognitive aging*. *Current Directions in Psychological Science*, 2004. **13**(4): p. 140-144.
9. Verhaeghen, P. and J. Cerella, *Aging, executive control, and attention: A review of meta-analyses*. *Neuroscience and Biobehavioral Reviews*, 2002. **26**(7): p. 849-857.
10. Mallon, K. and J.M. Wood, *Occupational therapy assessment of open-road driving performance: validity of directed and self-directed navigational instructional components*. *American Journal of Occupational Therapy*, 2004. **58**: p. 279-286.
11. Burns, P.C., *Navigation and the mobility of older drivers*. *Journals of Gerontology*, 1999. **54**: p. S49-S55.
12. Liu, Y., *Comparative study of the effects of auditory, visual and multimodality displays on drivers' performance in advanced traveller information systems*. *Ergonomics*, 2001. **44**: p. 425-442.
13. Dingus, T.A., et al., *Effects of age, system experience, and navigation technique on driving with an Advanced Traveler Information System*. *Human Factors*, 1997. **39**(2): p. 177-199.
14. Czaja, S.J. and C.C. Lee, *The impact of aging on access to technology*. *Universal Access in the Information Society*, 2007. **5**: p. 341-349.
15. Australian Bureau of Statistics, *2006 Census data: Victoria, age by sex*. 2006, Australian Bureau of Statistics.
16. Cohen, J., *Statistics a power primer*. *Psychology Bulletin*, 1992. **112**: p. 155-159.
17. Charlton, J., et al., *Safe vehicle choices for older adults*. 2002, Royal Automobile Club of Victoria (RACV): Melbourne, Australia.