Do older rural drivers self-regulate their driving? The effects of increased driving importance and limited alternative transportation

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Abstract

This study examined whether older rural drivers are restricted in the ability to self-regulate their driving by the importance they attribute to driving and reduced access to alternative transportation. A sample of 170 drivers (aged ≥ 75) from rural and urban areas of South Australia completed a questionnaire on driving importance, alternative means of transportation and driving self-regulation. Rural participants viewed their driving as more important than urban participants did and believed that they had less public transport available to them, used public transport less and had fewer other alternative means of transportation (e.g., taxi) available. However, they did not differ on indices of self-regulation (avoidance of difficult driving situations, reductions in amount of driving and willingness to stop driving). Thus, older rural drivers' self-regulation is not restricted by increased driving importance or limited alternative transportation. However, limited alternative transportation is still viewed as a disadvantage to mobility.

Keywords

Driving behaviour, Older drivers, Rural, Self-regulation, Transportation services, Urban

Introduction

Older drivers (generally defined as 65 years and older) have an elevated crash rate per kilometre driven (1, 2) and have an increased risk of being seriously or fatally injured if they are involved in a crash (2-6). However, it is important that older drivers do not cease driving prematurely because the mobility that driving provides is important to maintaining their independence and an active lifestyle (7-9). Moreover, a loss of mobility can lead to depression (4, 10, 11), a reduced network of friends (12) and an increased risk of mortality in the ensuing 3-year period (13). Recent research has therefore emphasised the importance of older adults maintaining their driving mobility for as long as possible, provided it is safe for them to do so (14-16).

One way in which older adults can both prolong their driving mobility and potentially reduce their crash risk is by self-regulating their driving behaviour (17, 18). Self-regulation involves individuals assessing any deterioration in their driving, cognitive and functional abilities, as well as their health, and then adjusting their driving behaviour either through an overall reduction in the amount of driving they do or by avoiding specific driving situations that an individual finds difficult (e.g. driving at night). This then reduces a driver's exposure to difficult conditions and, consequently, their crash and injury risk, while maintaining some degree of mobility. Self-regulation may also include the decision to stop driving when an individual believes that they are no longer safe on the road.

Ideally, greater self-regulation should be practised by those older drivers who are most at risk of being involved in a crash and of sustaining a serious or fatal injury in the event of a crash, with those drivers who are at a lower risk of these outcomes adopting fewer restrictions on their driving. Research by Thompson et al. (6) has revealed that drivers who are aged over 75 years and who live in rural areas of South Australia are more than twice as likely as their urban counterparts to be seriously or fatally injured when involved in a crash, suggesting that this is one group for whom self-regulation may be a useful strategy to avoid crash involvement and resulting injury. However, there are a number of reasons why older rural residents may find it more difficult to practice self-regulation than their urban counterparts. Firstly, rural residents are more likely to need to drive in order to access important community services (e.g., doctor, supermarket) and to maintain their community involvement. Consequently, they may be less willing to reduce or stop driving, as it would have a greater effect on their independence and lifestyle than would be the case for urban residents who have shorter distances to travel in order to access community services.

Secondly, self-regulation may be problematic in rural areas because access to public transport (19) and the availability of friends and family to provide transportation (20) is often more limited. Other transport options, such as community buses and taxis are also less likely to be available, further increasing the importance of driving for older rural adults.

The intention of the present study was to determine whether older rural drivers are restricted in their ability to self-regulate their driving by the importance they attribute to driving and the availability of alternative transportation in rural areas. To date, there has not been any research which has examined this issue but it is important to understand because if they are restricted in their ability to self-regulate then this reduces the level of control that they have over their safety on the road. Furthermore, it is important to understand the possible causes so that they can potentially be addressed.

Method

Participants

Participants were recruited through an appeal to people who attended the South Australian Royal Automobile Association's (RAA) "Years Ahead" community presentations. The RAA is an independent automobile club in SA, which has approximately 560,000 members and provides a range of services, including road safety information. The "Years Ahead" presentations are given at churches and senior citizens' clubs in both rural and urban areas of South Australia, and provide information on road safety that is specifically relevant to older adults. One of the researchers (JPT) attended these presentations, spoke about the research, and invited individuals to participate.

To be eligible, participants had to be aged 75 years or older. This age range was chosen to define an "older driver" based on a parallel study (6), which found that drivers 75 years and older were significantly more likely to be seriously or fatally injured when involved in a crash than drivers below this age. In addition, participants were required to hold a valid driver's licence for a car, drive regularly (i.e. more than once in the previous month), and be fluent in English (in order to complete the questionnaires).

A total of 170 eligible participants (71 females, 99 males) completed the study questionnaire. Of these, 64 (38%; 27 females, 37 males) resided in rural areas and 106 (62%; 44 females, 62 males) lived in urban areas of South Australia. Urban areas of South Australia were defined as the capital city, Adelaide, and a surrounding 5-20 kilometre region, while rural areas were defined as those outside of the Adelaide area but within a two hour drive from the centre of Adelaide (a radius of approximately 100 kilometres). The age of the participants ranged from 75 to 94, with a mean of 79.9 years (SD = 4.0). The mean age of the rural participants was 79.1 years (SD = 3.8), while for the urban participants it was 80.5 years (SD = 4.0).

The sample was compared to data on licensed drivers aged 75 and over in South Australia for the year 2009 to determine whether it was representative of the older driver population. The data were obtained from the South Australian Department of Planning, Transport and Infrastructure for the year 2009 and for individuals with a class C driver's licence (able to drive non-commercial motor vehicles not exceeding 4,500kg). There were 60,602 licensed drivers aged 75 and over in South Australia in 2009, 28% from rural areas and 72% from urban areas. There were 83% of the population in the 75-84 age group and 17% in the 85 and over group, compared to 86% and 14% for the sample. Therefore, the age composition of the sample appears to approximate that of the population.

Measure

Participants completed a 'Driving Patterns Questionnaire' (DPQ). The DPQ was developed and trialled specifically for use in the present research as no other appropriate measures existed. It was divided into four parts (background information, driving importance, alternative means of transportation and driving self-regulation). The first part sought background information on the participants, including the postcode for their home residence (four digit code, used to determine whether they lived in a rural or urban area); age (in years) and gender; highest level of education that they had completed (six options: some secondary or high school, completed high school, trade/technical college, certificate or diploma, university degree, postgraduate degree); and whether they held a valid driver's licence for a car (yes or no) and had driven in the last month.

The *Driving Importance* section included six items asking participants to report how strongly they agreed with statements indicating that driving is important for various reasons, such as for independence (for a full list see Table 1 in the Results section). Each item was rated on a four-point scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). Responses to these items were aggregated to provide an overall measure of driving importance, with scores potentially ranging from 6 (not important) to 24 (extremely important).

The *Alternative Means of Transportation* section asked participants whether convenient public transportation was available (yes or no) to get them to four common destinations (doctor, supermarket, friends and family, and social activities). The "yes" responses were summed for each participant to provide an overall 'availability of public transportation' score, ranging from 0 to 4. Next, participants indicated how often they used public transportation (never, rarely, sometimes, often). A four-point scale was applied to these responses (0 = never, 3 = often). They also had to indicate which of seven other alternative means of transportation, such as taxis (for a full list see Table 3 in the Results section) they believed would be available to them

if they had to stop driving. A total 'available alternative means of transportation' score was then calculated for each participant by tallying the options that were marked, ranging from 0 (no alternative means) to an unlimited number because "other" (i.e., any number of alternative means that they believed would be available to them) was included.

The final section, *Driving Self-Regulation*, asked the participants to rate their level of avoidance during the past year of nine difficult driving situations, such as driving at night (for a full list see Table 4 in the Results section), using a five-point scale (1 = never avoid, 2 = rarely avoid, 3 = sometimes avoid, 4 = often avoid, 5 = always avoid). The sum of the ratings for these items provided an overall driving avoidance score, ranging from 9 (never avoid any driving situations) to 45 (always avoid all difficult driving situations). These questions, as well as the scale and overall score, have been widely used in previous research on older drivers to measure self-regulation (18, 21-23). Indeed, this was the only part of the DPQ that was not developed specifically for the present research. It was chosen so that the results could be compared to other research. Next, participants had to specify how much they had reduced the amount that they drove in the past year, choosing from four options (not at all, somewhat, reasonably, greatly). A four-point scale was applied to these options (0 = not at all to 3 = greatly). Finally, they had to specify the degree to which they agreed with statements indicating that they would stop driving given certain situations, such as their doctor recommended it (for a full list see Table 5 in the Results section), using a four-point scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). The aggregate of the responses to these five items provided an overall measure of participants' willingness to stop driving, with scores potentially ranging from 5 (not willing) to 20 (completely willing).

Procedure and statistical analyses

The attendees at the "Years Ahead" presentations who agreed to participate were provided with a copy of the questionnaire, an information sheet about the research, two copies of a consent form and a reply paid envelope. The questionnaire was completed by the participant at home and mailed back to the investigator, along with one of the signed consent forms (the other was kept by the participant). Ethics approval for the research was granted by the Human Research Ethics Subcommittee in the School of Psychology at the University of Adelaide. Prior to completing the questionnaire, the participants were reminded that they could withdraw from the study at any stage and assured that their responses would remain confidential.

The data obtained from the questionnaires were used to compare the rural and urban participants to determine whether there were any differences between them in terms of (a) the importance of driving, (b) the public transportation available to them, (c) their usage of public transportation, (d) the other alternative means of transportation available to them, and (e) their driving self-regulation (in terms of avoidance of difficult driving situations, reductions in amount of driving in the past year and willingness to stop driving given reasons to do so). Independent samples *t*-tests were used for these between-participants comparisons, except for the comparisons of their usage of public transportation and the amount that they had reduced their driving in the past year as these were measured on ordinal scales and, therefore, chi-square tests were used. Cohen's *d* effect sizes were calculated for the t-tests to evaluate the magnitude of any group differences, with $d = .2, .5$ and $.8$ equating to small, medium and large effect sizes, respectively (24).

They were also compared to determine whether they differed in terms of (f) the effect that driving importance, availability of public transportation, usage of public transportation and availability of other alternative means of transportation had on the degree to which they self-regulate their driving. For this comparison, the measures of driving importance, availability of convenient public transportation, usage of public transportation, and availability of other alternative means of transportation were used as independent variables in three regression models. Linear regression was used in models 1 and 2, with the overall measure of avoidance of difficult driving situations as the dependent variable in model 1 and the overall measure of willingness to stop driving in model 2. In model 3 the dependent variable was the measure of driving reduction in the past year. However, this measure used an ordinal four-point scale, which limited the variance. Therefore, logistic regression was used with the data analysed in binary terms, namely whether the participants did (i.e., a response of "somewhat", "reasonably" or "greatly") or did not reduce their driving (i.e., response "not at all"). The three models were examined separately for rural and urban participants (total of six analyses) so that the effects of the independent variables on the three dependent variables could be determined for each group independently and then compared. The age of the participants was also entered as an independent variable in the models because older age has been shown to be associated with increased self-regulation (25-29) and could therefore mediate the effects of the other independent variables on the three dependent variables.

For all analyses, an alpha level of .05 was used to determine statistical significance. Also, in order to identify significant differences of either direction between the rural and urban groups, all of the analyses were two-tailed.

Results

Demographic comparison of rural and urban drivers

The age, education and gender composition of the rural and urban groups were initially compared to assess whether there were any demographic differences between the two groups. These analyses revealed that there were no significant differences between the two groups in terms of their level of education, $t(163) = .58$, $p = .561$, or gender, $\chi^2(1, N = 170) = .01$, $p = .931$. While the urban participants had a significantly higher mean age (80.5, $SD = 4.0$) than the rural participants (79.1, $SD = 3.8$), $t(168) = 2.26$; $p = .025$, the difference of only one year equates to a small effect size (Cohen's $d = .36$) and is unlikely to be of practical significance in terms of driving behaviour.

Driving importance

The mean overall driving importance scores for the rural (20.4, $SD = 3.0$) and urban participants (19.5, $SD = 2.8$) were both high, given that scores could range from 6 to 24. The difference between these means was small ($d = .34$) but significant, $t(153) = 2.07$; $p = .040$, suggesting that driving is more important to meeting the day-to-day needs of older rural drivers. Responses to the individual items are summarised in Table 1, where it can be seen that the greatest differences between rural and urban participants were for the three items relating to the availability of other sources of transportation (public transport, friends, family), with more rural participants strongly agreeing with statements that these sources were not available to them and more urban participants disagreeing with these statements.

Table 1. Perceived importance of driving for six reasons: rural and urban responses

Reason		Level of Agreement (%)			
		Strongly disagree	Disagree	Agree	Strongly agree
For accessing necessary services (e.g., doctor)	Rural	1.7	5.2	37.9	55.2
	Urban	1.0	2.1	39.2	57.7
Because public transportation is unavailable	Rural	3.4	3.4	34.5	58.6
	Urban	6.2	30.9	40.2	22.7
Because friends are unavailable to provide transportation	Rural	3.4	8.6	43.1	44.8
	Urban	7.2	21.6	42.3	28.9
Because family are unavailable to provide transportation	Rural	5.2	12.1	44.8	37.9
	Urban	6.2	22.7	46.4	24.7
For independence	Rural	0.0	0.0	43.1	56.9
	Urban	0.0	0.0	25.8	74.2
For community involvement/ active lifestyle	Rural	0.0	5.2	43.1	51.7
	Urban	1.0	1.0	39.2	58.8

Note: six rural and nine urban participants did not give valid responses to these items. Therefore, $n = 155$ for these analyses, 58 rural and 97 urban.

Alternative means of transportation

In terms of the overall availability of public transportation, rural participants had a mean score (0.7, *SD* = 1.3), which indicates low levels of availability (possible range: 0 - 4), compared to that of urban participants (1.2, *SD* = 1.3). The difference between these means was low-medium in size ($d = .44$) and significant, $t(161) = 2.74$; $p = .007$, indicating that older adults from rural areas have moderately less public transportation available to them than those from urban areas. This was also reflected in the responses to the individual items in the measure (see Table 2), with particularly large differences in access to transport that would enable residents to get to supermarkets.

In terms of the amount that the rural participants used public transportation, 46.0% reported "never" using it, 36.5% reported "rarely", 14.3% reported "sometimes", and 3.2% reported "often". For the urban participants, 2.9% reported "never" using it, 33.3% reported "rarely", 56.2% reported "sometimes", and 7.6% reported "often". Therefore, more rural than urban participants responded with "never" and "rarely", while more urban participants responded with "sometimes" and "often". Moreover, there was a significant association between rural/urban residence and use of public transportation, $\chi^2(3, n = 168) = 57.04$, $p < .001$, with the Cramer's V statistic of .58 indicating that 34% of the variation in usage by older adults was explained by whether they lived in a rural or urban area. Thus, older rural drivers appear to use public transportation less than their urban counterparts.

Rural participants reported that they had an average of 2.4 (*SD* = 1.0) alternative means of transportation available to them if they needed to stop driving, which was significantly fewer than the average number available to urban participants (mean = 3.2, *SD* = 1.3), $t(167) = 4.10$; $p < .001$, $d = .67$. Older rural drivers therefore have fewer alternative means of transportation available to them. This was reflected in the responses regarding the availability of each individual alternative means of transportation (see Table 3), where, for most of the options, fewer rural participants reported that they were available than urban participants. The biggest difference was for public transportation, which supports the finding in the previous section that rural participants had less public transportation available to them. Unexpectedly, however, more rural participants indicated that their friends and their partner were available.

Table 2. Percentages of rural and urban participants who indicated that convenient public transportation was available to get them to four common destinations

Destination		%
Doctor	Rural	14.5
	Urban	29.7
Supermarket	Rural	17.7
	Urban	51.5
Friends and family	Rural	16.1
	Urban	15.8
Social activities	Rural	16.1
	Urban	24.8

Note: two rural and five urban participants did not give valid responses to these items. Therefore, $n = 163$ for these analyses, 62 rural and 101 urban.

Table 3. Alternative means of transportation: percentages of participants (rural and urban) who indicated that the relevant option was available to them

Alternative means of transportation		%
Community transportation	Rural	31.3
	Urban	46.7
Public transportation	Rural	34.4
	Urban	88.6
Friends could drive me	Rural	37.5
	Urban	35.2
Family could drive me	Rural	35.9
	Urban	50.5
Husband/wife/partner could drive me	Rural	54.7
	Urban	37.1
Taxi	Rural	34.4
	Urban	48.6
Other[a]	Rural	9.4
	Urban	9.5

Note: one urban participant did not give a valid response to this item. Therefore, $n = 169$ for these analyses, 64 rural and 105 urban.
[a] "other" responses included using a gopher, walking, and riding a bicycle.

Driving self-regulation

When the extent to which rural and urban drivers were using self-regulation to limit their exposure to risky driving situations was compared, it was found that rural participants had an overall mean of 17.6 ($SD = 7.4$) on the measure of avoidance of difficult situations, while the urban participants had a mean of 15.8 ($SD = 6.7$). Both rural and urban scores were low (possible range: 9 - 45) and the difference between the means was small ($d = .25$) and not significant, $t(161) = 1.55$; $p = .123$; indicating that neither group actively self-regulates their driving. Indeed, the levels of avoidance reported for each of the difficult situations individually (see Table 4) were similar for rural and urban participants.

Table 4. Avoidance of individual difficult driving situations: rural and urban responses

Driving situation		Level of Avoidance (%)				
		Never	Rarely	Sometimes	Often	Always
In the rain	Rural	57.1	20.6	19.0	3.2	0.0
	Urban	65.0	20.0	13.0	2.0	0.0
When alone	Rural	82.5	7.9	7.9	1.6	0.0
	Urban	91.0	6.0	3.0	0.0	0.0
Parallel parking	Rural	34.9	20.6	19.0	15.9	9.5
	Urban	47.0	21.0	19.0	6.0	7.0
Right turns	Rural	54.0	28.6	14.3	0.0	3.2
	Urban	60.0	23.0	13.0	3.0	1.0
Freeways	Rural	68.3	17.5	4.8	7.9	1.6
	Urban	73.0	12.0	8.0	6.0	1.0
High traffic roads	Rural	55.6	15.9	15.9	11.1	1.6
	Urban	61.0	19.0	16.0	4.0	0.0
Peak hour	Rural	42.9	12.7	20.6	11.1	12.7
	Urban	45.0	27.0	21.0	7.0	0.0
At night	Rural	38.1	22.2	23.8	6.3	9.5
	Urban	53.0	15.0	9.0	9.0	14.0
At night in the rain	Rural	46.0	12.7	23.8	3.2	14.3
	Urban	49.0	16.0	10.0	5.0	20.0

Note: one rural and six urban participants did not give valid responses to these items. Therefore, n = 163 for these analyses, 63 rural and 100 urban.

In terms of the amount that the rural participants had reduced their driving in the past year, 57.1% reported "not at all", 20.6% reported "somewhat", 14.3% reported "reasonably", and 7.9% reported "greatly". For the urban participants, 50.9% reported "not at all", 34.0% reported "somewhat", 10.4% reported "reasonably", and 4.7% reported "greatly". Thus, the responses to this question were similar for rural and urban participants. Indeed, a 2 x 4 χ^2 showed no significant association between rural/urban residence and any reduction in driving, $\chi^2(3, n = 169) = 3.91$, $p = .272$, with a small Cramer's V statistic of .27.

In terms of overall willingness to stop driving, the mean scores for both rural (16.8, *SD* = 1.8) and urban participants (16.4, *SD* = 2.4) were high (possible range: 5 - 20). The difference between the means was small (*d* = .21) and not significant, $t(151) = 1.23$; $p = .222$, suggesting that older rural and urban drivers do not differ in their willingness to stop driving. Indeed, the responses to the specific reasons to stop driving were similar for rural and urban participants (see Table 5).

Prediction of levels of self-regulation of driving

The first regression model, which examined the effects of the independent variables (driving importance, availability of convenient public transportation, usage of public transportation, and availability of other alternative means of transportation) on avoidance of difficult driving situations, was not statistically significant for the rural, $F(5, 51) = .73$; $p = .603$, or urban participants, $F(5, 83) = 1.52$; $p = .194$, with the independent variables only accounting for -.03% and .03% of the variance in avoidance of difficult driving situations, respectively (adjusted R^2). It can be seen from Table 6 that age had a significant effect on the self-regulation of urban but not for rural drivers, while none of the other independent variables had any significant effects.

The second regression model, which examined the effects of the independent variables on willingness to stop driving, was also not significant for the rural, $F(5, 48) = .60$; $p = .704$, or urban participants, $F(5, 81) = 1.81$; $p = .121$, with the independent variables only accounting for -.04% and .05% of the variance in willingness to stop driving

Table 5. Willingness to stop driving for five reasons: rural and urban responses

Reason to stop driving		Level of Agreement (%)			
		Strongly disagree	Disagree	Agree	Strongly agree
Doctor recommendation	Rural	0.0	3.4	56.9	39.7
	Urban	1.1	3.2	55.8	40.0
Friends and family	Rural	3.4	15.5	56.9	24.1
recommendation	Urban	5.3	20.0	56.8	17.9
Not confident enough	Rural	0.0	1.7	56.9	41.4
	Urban	1.1	4.2	50.5	44.2
Health and driving	Rural	0.0	0.0	39.7	60.3
abilities not at safe level	Urban	0.0	0.0	45.3	54.7
Caused a serious	Rural	0.0	10.3	36.2	53.4
accident	Urban	1.1	14.7	46.3	37.9

Note: six rural and eleven urban participants did not give valid responses to these items. Therefore, *n* = 153 for these analyses, 58 rural and 95 urban.

(adjusted R^2). However, in Table 6 it can be seen that the effect of the variable 'availability of other alternative means of transportation', while not significant for rural drivers, was significant for urban drivers (p = .016). For every additional means of transportation available to an older urban driver, their willingness to stop driving increased by 0.49 of a unit on the scale of 5 to 20. This suggests that availability of other alternative means of transportation has an effect on willingness to stop driving for older urban drivers but not for older rural drivers.

Finally, the third regression model, which examined the effects of the independent variables on whether an older driver would reduce their driving or not, was also not statistically significant for the rural, $\chi^2(5, n = 57) = 1.93$; p = .859, or urban participants, $\chi^2(5, n = 90) = 6.02$; p = .304. The independent variables only accounted for .03% and .07% of the variance in driving reduction (Cox & Snell R^2). None of the independent variables significantly predicted whether an older driver would or would not reduce their driving (see Table 6).

Table 6. Results of linear regression to predict avoidance of difficult driving situations (model 1) and willingness to stop driving (model 2), and logistic regression to predict driving reduction in the past year (model 3), for rural and urban participants separately

		Independent Variable	B[a]	Beta[b]	*t*	*p*-Value
Model 1	**Rural**	Driving importance	0.39	0.16	1.12	0.268
		Avail. of public transportation	0.81	0.14	1.00	0.323
		Usage of public transportation	0.43	0.05	0.35	0.727
		Avail. of alternative transportation	0.85	0.12	0.84	0.403
		Age	0.01	<0.01	0.02	0.986
	Urban	Driving importance	-0.04	-0.02	-0.14	0.890
		Avail. of public transportation	-0.26	-0.05	-0.40	0.693
		Usage of public transportation	1.00	0.10	0.89	0.374
		Avail. of alternative transportation	0.58	0.11	1.01	0.315
		Age	0.48	0.27	2.48	0.015*
Model 2	**Rural**	Driving importance	0.11	0.18	1.19	0.242
		Avail. of public transportation	-0.09	-0.06	-0.40	0.689
		Usage of public transportation	0.04	0.02	0.13	0.898
		Avail. of alternative transportation	0.20	0.12	0.78	0.439
		Age	0.03	0.06	0.42	0.679
	Urban	Driving importance	-0.07	-0.08	-0.70	0.488
		Avail. of public transportation	0.07	0.03	0.29	0.771
		Usage of public transportation	0.30	0.09	0.78	0.440
		Avail. of alternative transportation	0.49	0.27	2.47	0.016*
		Age	0.07	0.12	1.09	0.280
			B[a]	**Odds**	**Wald**	***p*-Value**

				Ratio		
Model 3	**Rural**	Driving importance	<0.01	1.00	<0.01	0.973
		Avail. of public transportation	-0.30	0.74	1.32	0.252
		Usage of public transportation	-0.19	0.83	0.28	0.598
		Avail. of alternative transportation	-0.01	0.99	<0.01	0.984
		Age	-0.01	0.99	0.02	0.886
	Urban	Driving importance	-0.04	0.97	0.15	0.696
		Avail. of public transportation	-0.11	0.90	0.33	0.568
		Usage of public transportation	0.50	1.65	2.08	0.149
		Avail. of alternative transportation	0.10	1.11	0.36	0.547
		Age	0.11	1.12	3.42	0.065

[a] the results for B are unstandardised coefficients.

[b] the results for Beta are standardised coefficients.

* $p < .05$.

Discussion

This study demonstrated that driving is perceived to be more important to meeting the day-to-day needs of older rural drivers than it is to older urban drivers. It also found that older rural drivers report that public transportation and other alternative means of transportation are not as readily available to them. Indeed, the main reasons for driving being more important to older rural drivers were the limited availability of public transportation, and friends and family who could assist with their transport needs.

A comparison of the importance that is placed on driving by older drivers from rural and urban areas has not previously been undertaken and, therefore, this is the first time that the greater importance of driving to older rural drivers has been demonstrated. Similar findings have been found previously regarding the availability of alternative means of transportation. Corcoran et al. (19) found that public transportation was limited for people aged over 65 years living in a rural region of Victoria, Australia. In addition, a survey of older adults from rural areas in the USA by Johnson (20) indicated that their friends and family often lived a long distance away, making assistance with transportation difficult. Interestingly, in the current study more rural participants suggested that their friends, as well as their partner, were available to provide transportation. The availability of community transport and taxis for rural and urban older persons has not been compared previously. More rural participants indicated that neither were readily available.

The limited availability of public transportation is likely to be responsible for the finding that rural participants were using it less frequently. For the urban participants, public transportation options were greater, as was their usage of it, suggesting that older adults increase their usage of public transportation when it is available.

Based on the importance of driving for older rural drivers and the limited availability of alternative transportation, it might be expected that they would be less able to avoid, reduce or stop driving. However, older rural drivers did not differ from older urban drivers in their avoidance of difficult driving situations, the amount that they had reduced their driving in the past year, or their willingness to stop driving. This suggests that they are able to self-regulate their driving to a similar degree as older urban drivers and that they are not restricted in doing so by the greater importance they place on driving or the limited alternative transportation available to them. Indeed, based on the multivariate regression analyses, it appears that driving importance, the availability of public transportation, usage of public transportation and the availability of other alternative means of transportation do not affect the degree to which older drivers from rural and urban areas self-regulate. However, the availability of other alternative means of transportation did affect the willingness of urban drivers to stop driving. This is consistent with Choi, Adams and Kahana's (30) finding that older adults are more likely to stop driving if they have transport support from friends and neighbours, as well as other organisations, such as churches.

Study limitations and future directions

There were several limitations to this study. Firstly, self-report measures can be unreliable as the participants may accidently report inaccurate information. They may also attempt to portray a socially desirable account of themselves through the information they provide. For example, they may report that they are more willing to stop driving than would perhaps actually be the case. This may have affected the results.

The samples of rural and urban participants were small for the purposes of the regression analysis, which had multiple independent variables, thereby limiting statistical power. Also, there are other factors which were not assessed in this study that may affect the degree to which older drivers are able to avoid, reduce or stop driving. These include the distance from the participants' residences to necessary services, as well as to their friends and family, and whether recommendations to avoid, reduce or stop driving had been made to the participants by their friends, family or doctor. These variables and their effect on self-regulation could be examined in future research.

The rural participants were recruited from rural areas in South Australia that were relatively close to the capital city (i.e., within approximately two hours driving distance). For practical reasons, it was not possible to recruit older drivers from more remote areas of the state. Driving is likely to be even more important to persons from such areas and alternative transportation is likely to be less available, making it even harder for persons living in more remote rural areas to avoid, reduce or stop driving. If individuals from remote areas had participated, it may have affected the findings relating to self-regulation. Those living in remote areas should be recruited in future research.

The majority of both rural and urban participants indicated that they "never" or "rarely" avoided each of the difficult driving situations, reducing the variability in the scores for this measure. Other studies have also found low levels of avoidance using the same measure (18, 21, 22, 31). While the low scores may truly suggest that older drivers do not generally avoid these situations, they may also result from limitations in the measure.

On the basis of low scores on the measure of avoidance of difficult driving situations, a study by Sullivan et al. (31), which was published after the design and data collection stages of the present study, recommended that the items in the measure should be reconsidered as they may not be the only situations which older drivers avoid. The participants in the Sullivan et al. study were required to report which situations they view as safe and unsafe. Although this process did identify the situations that are currently in the measure as unsafe, thereby validating their inclusion, a range of other situations were also identified as unsafe. Sullivan et al. suggested that these additional unsafe situations could be included in a modified scale. It is likely that the present research would have benefited from a modified scale, particularly as some of the situations in the current scale (e.g., driving in peak hour) may not apply to older rural drivers. Furthermore, some of the current situations (e.g. parallel parking) can be avoided in everyday driving without having to use alternative transportation instead of driving and are unlikely to be affected by perceptions of driving importance, so these items may need to be reconsidered for future studies looking at driving importance and alternative transportation. Of the items suggested by Sullivan et al., those that would have been valuable for inclusion in the present study include 'long distance driving', 'driving in foggy conditions', 'driving when other drivers might endanger me' and 'driving when I think other drivers will put me at risk'.

The low rates of self regulation may also reflect that the sample was recruited through senior citizens' clubs and churches. Such people, and particularly those willing to volunteer for the study, may be more active, healthy and community-minded than typical adults in the same age group. In addition, they had to travel from their homes to the meeting location, suggesting that they are amongst the more mobile older residents. Past research has shown that the degree to which older drivers self-regulate is associated with their health, medical conditions and certain functional and cognitive abilities (22, 25, 32, 33). The participants in the present study may not have needed to self-regulate as much because they were healthy and highly functioning; variables that were not measured in the current study. Future research would benefit from assessment of the functional and cognitive abilities of the sample, as well as by recruiting participants with a broad range of health and cognitive and functional abilities, including those with impairments in these abilities. It would also benefit from recruiting people who have reduced mobility (i.e., not just those who are mobile enough to attend community meetings). This may provide a better indication of whether rural older drivers are able to self-regulate appropriately. Despite this, however, the sample was found to be representative of the older driver population in South Australia in terms of age composition.

Finally, the scores for the measure of changes to the amount of driving in the past year were also low, with around half of the participants reporting that they had not reduced their driving during this period. This may also have been due to a healthy and highly functioning sample who did not need to reduce their driving. It may also reflect limitations with the measure. Specifically, people were required to provide ratings using a scale that only included four nominal responses (i.e., not at all, somewhat, reasonably, greatly), which provided limited detail regarding the exact amount of

change. In addition, retrospective estimation over the past year is prone to error. Future research would benefit from a more detailed measure.

Conclusion

Overall, rural and urban older drivers were not found to differ in the degree to which they self-regulate their driving. Given that older rural drivers are more than twice as likely as their urban counterparts to be seriously or fatally injured in a crash (6), there may be a greater need for these drivers to adjust their driving behaviour in order to maintain their safety. It may be beneficial, therefore, to encourage older rural drivers to increase their self-regulation. Particular emphasis could be given to assisting them to adjust their driving in such a way that it has the least detrimental effect on their mobility, while providing the best safety outcomes.

Despite finding that the availability of public transport and other alternative means of transportation did not affect the degree to which older drivers self-regulate, it is important to provide a transportation system that adequately meets the needs of older adults and supports drivers in their decision to adjust, reduce or stop driving. This study suggests that older rural adults are disadvantaged in terms of public transportation and other alternatives. A solution would be to increase public transportation services (e.g. buses, trains) or subsidise private services (e.g. taxis) in rural areas. While it may be possible to increase public transport options in large rural communities, the cost may be prohibitive in smaller communities. Alternatively, local councils, as well as independent groups, such as churches and senior citizens clubs, could be encouraged to increase their provision of community-run transportation services (e.g., community buses that transport people to organised destinations or volunteer driver systems). These services not only reduce the reliance on the personal automobile but are also convenient and encourage community participation.

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References

1. Baldock MRJ, McLean AJ. Older drivers: Crash involvement rates and causes. Adelaide: Centre for Automotive Safety Research, 2005. Report No.: CASR015.
2. Ryan GA, Legge M, Rosman D. Age related changes in driver's crash risk and crash type. Accident Analysis and Prevention. 1998;30(3):379-87.
3. Hanrahan RB, Layde PM, Zhu S, Guse CE, Hargarten SW. The association of driver age with traffic injury severity in Wisconsin. Traffic Injury Prevention 2009;10(4):361-7.
4. Langford J, Koppel S. The case for and against mandatory age-based assessment of older drivers. Transportation Research Part F. 2006;9(5):353-62.
5. Meuleners LB, Harding A, Lee AH, Legge M. Fragility and crash over-representation among older drivers in Western Australia. Accident Analysis and Prevention. 2006;38(5):1006-10.
6. Thompson JP, Baldock MRJ, Mathias JL, Wundersitz LN. Older drivers in rural and urban areas: Comparisons of crash, serious injury, and fatality rates. In Australasian Road Safety Research, Policing and Education Conference; 2010; Canberra, Australian Capital Territory.
7. 7. Adler G, Rottunda S, Kuskowski M. Dementia and driving: Perceptions and changing habits. Clinical Gerontologist. 1999;20(2):23-35.
8. De Raedt R, Ponjaert-Kristoffersen I. The relationship between cognitive/neuropsychological factors and car driving performance in older adults. Journal of the American Geriatrics Society. 2000;48(12):1664-8.
9. Marottoli RA, Mendes de Leon CF, Glass TA, Williams CS, Cooney LM, Jr., Berkman LF. Consequences of driving cessation: Decreased out-of-home activity levels. Journal of Gerontology: Social Sciences. 2000;55B(6):S334-S40.
10. Fonda SJ, Wallace RB, Herzog AR. Changes in driving patterns and worsening depressive symptoms among older adults. Journal of Gerontology: Social Sciences. 2001;56B(6):S343-S51.
11. Marottoli RA, Mendes de Leon CF, Glass TA, Williams CS, Cooney LM, Jr., Berkman LF, et al. Driving cessation and increased depressive symptoms: Prospective evidence from the New Haven Established Populations for Epidemiological Studies of the Elderly. Journal of the American Geriatrics Society. 1997;45(2):202-6.
12. Mezuk B, Rebok GW. Social integration and social support among older adults following driving cessation. The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences. 2008;63B(5):S298-S303.
13. Edwards JD, Perkins M, Ross LA, Reynolds SL. Driving status and three-year mortality among community-dwelling older adults. The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences. 2009; 64A(2):300-5.
14. Anderson R, Anstey KJ, Wood J. The right approach for older drivers. Journal of the Australasian College of Road Safety. 2009;20(3):37-9.
15. Kostyniuk LP, Shope JT. Driving and alternatives: Older drivers in Michigan. Journal of Safety Research. 2003;34(4):407-14.
16. Oxley J, Whelan M. It cannot be all about safety: The benefits of prolonged mobility. Traffic Injury Prevention. 2008;9(4):367-78.
17. Berry C. Can older drivers be nudged? How the public and private sectors can influence older drivers' self-regulation. London: RAC Foundation, 2011.
18. Stalvey BT, Owsley C. Self perceptions and current practices of high risk older drivers: Implications for driver safety interventions. Journal of Health Psychology. 2000;5(4): 441-56.

19. Corcoran S, James EL, Ellis JM. Do elderly Victorians in rural areas have access to public transport? Road and Transport Research. 2005 March;14(1):38-43.
20. Johnson JE. Rural elders and the decision to stop driving. Journal of Community Health Nursing. 1995;12(3):131-8.
21. Baldock MRJ, Mathias JL, McLean AJ, Berndt A. Self-regulation of driving and its relationship to driving ability among older adults. Accident Analysis and Prevention. 2006;38:1038-45.
22. Baldock MRJ, Mathias JL, McLean J, Berndt A. Self-regulation of driving and older drivers' functional abilities. Clinical Gerontologist. 2006;30(1):53-70.
23. Baldock MRJ, Thompson JP, Mathias JL. Self-regulation of driving behaviour among older drivers: Findings from a five year follow-up. In Australasian Road Safety Research, Policing and Education Conference; 2008; Adelaide, South Australia.
24. Cohen J. A power primer. Psychological Bulletin. 1992;112(1):155-9.
25. Charlton JL, Oxley J, Fildes B, Oxley P, Newstead S, Koppel S, et al. Characteristics of older drivers who adopt self-regulatory driving behaviours. Transportation Research Part F. 2006;9:363-73.
26. Forrest KY, Bunker CH, Songer TJ, Coben JH, Cauley JA. Driving patterns and medical conditions in older women. Journal of the American Geriatrics Society. 1997;45(10):1214-8.
27. Gallo JJ, Rebok GW, Lesikar SE. The driving habits of adults aged 60 years and older. Journal of the American Geriatrics Society. 1999;47(3):335-41.
28. Raitanen T, Tormakangas T, Mollenkopf H, Marcellini F. Whey do older drivers reduce driving? Findings from three European countries. Transportation Research Part F: Traffic Psychology and Behaviour. 2003;6(2):81-95.
29. Rimmo PA, Hakamies-Blomqvist L. Older drivers' aberrant driving behaviour, impaired activity, and health as reasons for self-imposed driving limitations. Transportation Research Part F: Traffic Psychology and Behaviour. 2002;5(1):47-62.
30. Choi M, Adams KB, Kahana E. The impact of transportation support on driving cessation among community-dweling older adults. The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences. 2012;67(3): 392-400.
31. Sullivan KA, Smith SS, Horswill MS, Lurie-Beck JK. Older adults' safety perceptions of driving situations: Towards a new driving self-regulation scale. Accident Analysis and Prevention. 2011;43(3):1003-9.
32. Ball K, Owsley C, Stalvey B, Roenker DL, Sloane ME, Graves M. Driving avoidance and functional impaiment in older drivers. Accident Analysis and Prevention. 1998;30(3):313-22.
33. Owsley C, Stalvey B, Wells J, Sloane ME. Older drivers and cataract: Driving habits and crash risk. Journal of Gerontology: Medical Sciences. 1999;54A(4):M203-M11.

Validation of an in-vehicle monitoring device for measuring driving exposure and deceleration events

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Abstract

Background: In-vehicle monitoring is being used increasingly in research into driver behaviour. Advances in Global Positioning Systems (GPS), data management and telecommunications have made this a viable tool to objectively measure driving exposure and also speed patterns.

Aim: The purpose of this study was to validate an in-vehicle monitoring device in the laboratory where speed and deceleration can be controlled and in field experiments.

Methods: The device consists of a C4D Data Recorder with External GPS Receiver. The hardware includes an internal 3D accelerometer, tachograph, real-time clock, internal battery (1300mA) and 128MB of flash memory. The in-vehicle data logger transmits GPS location via the mobile telecommunications network. The device was evaluated in a laboratory and field tested to investigate the context for deceleration events. We developed algorithms to process summary data for driving routes and deceleration incidents.

Results and Discussion: Protocols were established for use of the device in the field and programs developed to extract events. The application of this technology is an innovative approach in driver behaviour and vehicle safety research.