# Self-regulation of driving behaviour among older drivers: Findings from a five year follow-up

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## Abstract

A follow-up study was conducted into the self-regulatory driving behaviours of a group of older drivers who had been interviewed four to five years previously. Fifty seven drivers aged from 66 to 97 years completed a questionnaire about their health and driving habits, and a sub-set of 44 participants additionally completed a battery of tests assessing psychological functioning, vision, mental status, speed of information processing, visuospatial memory and visual attention. These data were compared with the results obtained four to five years previously. It was found that there had been very little change in self-reported driving confidence and self-reported avoidance of difficult driving situations. However, this lack of change in driving habits contrasted with statistically significant declines in functional ability. Specifically, there were declines in mean scores for measures of mental status, visual acuity, contrast sensitivity and visual attention. These findings suggest that self-regulatory behaviour did not increase to compensate for declines in functioning.

## Keywords

Older driver, Self-regulation, Cognition, Vision, Visual attention

## Introduction

Concerns about the elevated rate of road fatalities and serious injuries per licensed driver and per distance driven among older drivers [1-3] has prompted researchers to investigate means of preventing road crashes among drivers in this age group. The solution of mandatory testing of driving ability for drivers once they get to a certain age has been put forward but research in Australia [4,5] and overseas [6] has not identified any road safety benefit resulting from such policies. Furthermore, the loss of a driver's licence has been found to be associated with negative outcomes for older adults' well-being [7]. Given this combination of findings, it could be argued that a middle ground between road safety and older adult mobility should be sought, such that drivers retain their licences but adopt driving practices that lessen the likelihood of crash involvement. This can be achieved through the practice of 'self-regulation' of driving behaviour, which involves drivers reducing their exposure to situations that they find difficult [1,8]. For example, a driver with poor eyesight may avoid driving at night and in the rain, or a driver experiencing difficulty in dividing attention under time pressure may avoid complex intersections, especially those requiring unprotected turns across oncoming traffic.

Ideally, self-regulation of driving behaviour by older adults would be practised to a greater extent by those whose driving is potentially affected by functional impairments. That way, the reduced exposure should act to eliminate or reduce potential crashes, while there would be no reduction of the mobility of those without functional impairments. Baldock, Mathias, McLean and Berndt [9,10] examined this by analysing the relationships between self-regulation, on-road driving ability and functional abilities in a sample of 104 older adults. It was found that those who performed more poorly on the structured on-road driving test were more likely to avoid driving at night, driving in the rain and driving at night in the rain [9], while drivers with poorer performance on measures of speed of information processing, visuospatial memory, and contrast sensitivity did not appear to compensate for these impairments with changes in driving behaviour [10].

These findings, however, were cross-sectional in nature, and it may be that changes in driving habits would be reported by study participants when measurable declines in abilities had occurred over time. To investigate this, participants from the study by Baldock et al. [9,10] conducted four to five years earlier were contacted to obtain follow-up measures of driving habits, specifically self-regulation, and functional abilities. The aim was to ascertain whether there had been increases in self-regulation of driving behaviour (avoidance of difficult driving situations) that would compensate for any declines in functioning (psychological, vision, cognition, speed of information processing, visuospatial memory, visual attention).

**Methods**

Participants

Participants were recruited from the pool of 104 community dwelling older adults who had been involved in an earlier study on self-regulation of driving behaviour [1]. A total of 57 older adults agreed to participate in the follow-up study. Their ages ranged from 66 to 97 (mean = 78.3, SD = 5.9) when the follow-up testing was conducted, compared to a range of 61 to 92 (mean = 73. 8, SD = 6.0) in the initial testing session. This is very similar to the age range of 60 to 91 (mean = 74.7, SD = 6.8) for the participants who either did not volunteer to be involved again or were not able to be contacted. Forty of the follow-up participants were female (70%), compared with 25 of the 47 remaining original participants (53%). Of the 57 participants in the present study, all but one still held a driver's licence. All participants had more than 10 years driving experience and none had had a traumatic brain injury, cerebrovascular accident (stroke) or other event causing a sudden loss of functioning in the inter-study period.

Materials

The materials for this study included a modified version of the Driver Mobility Questionnaire and a series of standard functional tests. These are described below.

The Driver Mobility Questionnaire (DMQ) was developed for the prior study and asks a series of questions related to driver health and behaviour. The questionnaire was shortened for the present study. Only sections relevant to the present study were administered again but no changes to the questionnaire were made within a section. There were two sections of the DMQ that were administered again and used in the analyses reported in this paper. The first of these sections was related to driver health. This section included a list of 14 medical conditions and asked participants to report whether they had the condition and the degree to which it affected their daily functioning on a three point scale. Participants were also asked to report any conditions they had that were not on the list. The sum of the self-ratings of the effects of medical conditions was used as a measure of participants' general health. Participants were also asked to list the medications they took more often than once a month. In order to classify the medications according to whether they were potentially hazardous to driving, details of the medications were obtained from the Monthly Index of Medical Specialities (MIMS). Medications described as commonly causing drowsiness, dizziness, or disturbance of central nervous system functioning were classified as "potentially hazardous to driving".

The other components of the questionnaire relevant to this paper were the measures of participants' confidence in, and avoidance of, difficult driving situations. These were based on measures from the Driving Habits Questionnaire [11]. For the confidence measure, participants had to rate their level of confidence in nine different driving situations (e.g. driving in the rain) on five point scales, with 1 = not at all confident and 5 = completely confident. For avoidance, participants had to report their level of avoidance of the same nine driving situations, with 1 = never avoid and 5 = always avoid. These two sets of ratings were summed to create an overall confidence score ranging from 9 (not at all confident in any difficult driving situation) to 45 (completely confident when driving) and an overall avoidance score ranging from 9 (no avoidance) to 45 (always avoid all difficult driving situations). Details of the reliability of the Driving Habit Questionnaire are provided in the original paper by Owsley et al. [11].

The Geriatric Depression Scale [12] is a 30-item questionnaire that assesses the presence of depressive symptoms and was designed specifically for elderly populations. Each item requires a yes/no response (sample question: do you frequently feel like crying?). Scores range from 0 to 30, with higher scores indicating a higher level of depressive symptoms.

The State-Trait Anxiety Inventory [13] is a two-part questionnaire assessing state anxiety (current level of anxiety) and trait anxiety (usual level of anxiety). Both parts consist of 20 items, each of which is a statement related to anxiety (e.g. I feel relaxed) requiring a response on a four point scale. Scores for each scale range from 20 to 80, with higher scores indicating a higher level of anxiety. Only state anxiety was measured in the follow-up study, as trait anxiety was assumed to have remained the same.

Snellen Static Visual Acuity was measured for each eye separately, and also binocularly, using a wall chart adjusted for a viewing distance of 3m. The smallest line for which the participant was able to read over half of the letters was recorded as their visual acuity level, with scores ranging from 6/5 (good acuity) to 6/60 (poor acuity).

Pelli-Robson Contrast Sensitivity [14] involves a wall chart displaying letters of constant size but varying levels of contrast with the background. The letters are arranged in sets of three with each set being of a lower contrast level than the preceding set. The chart is read at a distance of 1m, with both eyes separately and then binocularly. For each condition, the participant's contrast sensitivity level is the log of the lowest contrast level for which the participant is able to correctly identify two of the three letters in a set. Scores range from zero to 2.25, with higher scores indicating better contrast sensitivity.

The Modified Mini-Mental State Examination (3MS) [15] is an updated version of the Mini Mental State Examination [16] and measures basic cognitive functioning. Possible scores on the 3MS range from zero to 100 and it is possible to calculate a score out of 30 corresponding to the original Mini-Mental, for which a cut-off of 24 is standard for suspected dementia [17].

The Symbol Digit Modalities Test [18] measures speed of information processing. It features a code matching digits 1 to 9 with abstract symbols. Participants are provided with rows of boxes containing the symbols in random order and must produce the appropriate digit for each symbol. Scores are determined by the number of correctly matched digits produced in 90 seconds, with a maximum score of 110. There are two trials for the test, one involving written responses and one involving verbal responses. In this study, we only used the written responses.

The Spatial Span subtest of the third edition of the Wechsler Memory Scale [19] was used to measure spatial memory. It involves the test administrator touching the tops of a group of ten small cubes in a set pattern that the participant must then replicate. There is a forward subtest in which the participant must replicate the pattern exactly and a backward subtest in which the pattern must be produced in reverse order. For each subtest, the number of cubes in a pattern begins at two and progresses to nine, with two trials per level. The test ends when the participant fails to produce the correct pattern on both trials at any level. The score for both subtests is the number of trials for which the participant correctly produces the appropriate pattern. These are summed to produce a Total Spatial Span score ranging from zero to 32.

The Computerised Visual Attention Test (CVAT) was developed specifically for the initial study [1]. The CVAT requires participants to detect and react to targets in both central and peripheral vision, and was designed to measure selective and divided attention.

There are two different tasks in the CVAT: the primary task and the secondary task. The primary task requires participants to monitor a series of letters appearing on the left-hand side of the computer screen, one after another, at the rate of a new letter every 700 ms. Whenever the letter 'X' appears, participants have to press the space bar on the keyboard as quickly as possible, using a finger on their left hand. The secondary task requires participants to use their peripheral vision to detect the appearance of the picture of a car on the right side of the computer screen and to react by clicking a computer mouse as quickly as possible with their right hand. For the primary task, there is random variation in the frequency of appearance of Xs but no letter 'X' is followed directly by another X. On average, an X appears once every six letters. For the secondary task, in each set of trials, there are 27 cars to detect (three times in each position of a three by three matrix, varied randomly). The duration of time between the appearance of cars is either six, eight, ten, 12 or 14 seconds, and this is also varied randomly. This means that the total time for each set of trials is approximately five minutes.

In some CVAT subtests, the cars appear by themselves, whilst, in others, participants have to detect the cars appearing in the presence of visual distractors (schematic pictures of houses). These distractors are constantly present on the screen and move locations every two seconds. The distractors thus provide a cluttered visual array and also provide movement. By having the distractors move every two seconds, the appearance of a target (car) always coincides with movement of the distractors. This means that the simple cue of change (movement) in the periphery cannot be used to detect the cars. The visual distractors component of the task was designed to assess selective attention. The primary and secondary tasks (the latter with and without visual distractors) can be performed both separately and simultaneously, so that divided attention can also be assessed. In the initial study, there were five subtests, which were as follows:

- primary task only (X-detection): measure of simple attention in central vision
- secondary task only (car detection) without visual distractors: measure of simple attention in peripheral vision
- secondary task only with visual distractors (houses): measure of selective attention in peripheral vision
- dual task (primary and secondary tasks) without visual distractors on the secondary task: measure of divided attention, central and peripheral vision
- dual task with visual distractors on the secondary task: measure of divided and selective attention, central and peripheral vision

In the follow-up study, in order to reduce testing time, only the first two subtests and the fifth one were administered. This provided measures of simple attention in both central and peripheral vision, and a measure of selective and divided attention. The latter measure was the one most strongly related to driving performance in the original study.

Steps were taken to ensure that the secondary task was only performed using peripheral vision. Participants were explicitly instructed to focus their eyes on the central task of monitoring the letters appearing on the left side of the screen and to only use their peripheral vision to detect the stimuli of the secondary task appearing on the right side of the screen. The investigator sat alongside the participants and watched their eyes during performance of the task. Any participants who looked directly over at the peripheral stimuli were reminded of the need to focus on the central task. Participants were given as much practice as they desired for each combination of tasks. The order of the CVAT subtests was varied across participants to minimise the confounding effects of learning and fatigue.

Target detection failures and reaction times were measured for each of the CVAT subtests. Detection failures are hereafter referred to as 'detection errors'. False alarms (responding before the stimulus) were recorded and reaction time to the following target was discarded. Reaction times were also trimmed so that no reaction time was included if it was shorter than 200ms or longer than two seconds (thereby removing anticipatory responses or lapses in attention). The CVAT was pilot-tested and had its test-retest reliability assessed. It was found that scores (RTs and detection errors) for its various subtests had reliability coefficients ranging from .58 to .82, with the exception of the three detection error scores in the single task conditions (primary task only, secondary task only, secondary task only with visual distractors). Due to their low reliability coefficients, these scores were omitted from the correlation analyses in the initial study, and similarly for the analyses used in the follow-up study.

Procedure

Participants who agreed to be involved in the follow-up study were sent a copy of the Driver Mobility Questionnaire, which they completed at home. Next, participants attended an individual testing session at the University of Adelaide, in which they completed the functional tests. These sessions typically took 90 minutes. The order of the tests administered in the session was as follows: Geriatric Depression Scale, 3MS, first subtest of the CVAT, State-Trait Anxiety Inventory, Symbol Digit Modalities Test, second subtest of the CVAT, Spatial Span Test, third subtest of the CVAT, Snellen Visual Acuity, and Pelli-Robson Contrast Sensitivity. The same investigator administered all of the tests and measures to all of the participants. Participants gave written consent to be involved and were paid $40 each.

Changes in measures between the first and second testing sessions were analysed using paired t-tests for variables comprised of interval or ratio level data, and using Wilcoxon Signed Ranks tests for variables comprised of ordinal level data (e.g. visual acuity, driving confidence and avoidance measures). When analysing relationships between changes in variables, change scores were calculated (subtracting scores in the original study from scores in the present, follow-up study) and these change scores were analysed using Spearman's rho correlations. Spearman's rho was chosen on account of the ordinal data that formed the basis of some of the change scores.

**Results**

The means and standard deviations for variables taken from the DMQ are shown in Table 1. Included are the results for the entire sample (N = 57) and the sample who also completed the functional tests and whose results were used in subsequent analyses (N = 44). Using the N=44 sample as the basis for calculations, there was no difference between the two sets of scores (original versus follow-up studies) for the variables of general health, use of medications potentially hazardous to driving, confidence in difficult driving situations, or avoidance of difficult driving situations. However, by the time of the follow-up study, participants had increased their use of medication ($t_{43} = -3.5, p < .01$).

**Table 1** : Descriptive statistics for self-reported health and self-regulation variables for the follow-up and original studies, for the entire sample (N = 57) and the sub-set who also completed the functional tests (N =44).

| Measure | Original study | | Follow-up study | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| N = 57 | | | | |
| General Health | 2.5 | 1.8 | 2.6 | 2.1 |
| Medication Use | 1.7 | 1.8 | 2.3 | 2.1 |
| Hazardous medication use | 0.6 | 0.8 | 0.6 | 0.9 |
| Driving confidence | 33.8 | 6.3 | 34.2 | 6.7 |
| Driving avoidance | 13.3 | 5.5 | 14.0 | 5.8 |
| N = 44 | | | | |
| General Health | 2.5 | 1.9 | 2.5 | 2.0 |
| Medication Use | 1.7 | 1.8 | 2.4 | 2.1 |
| Hazardous medication use | 0.6 | 0.9 | 0.7 | 1.0 |
| Driving confidence | 33.7 | 6.6 | 33.9 | 6.8 |
| Driving avoidance | 13.1 | 5.9 | 14.2 | 6.2 |

Table 2 provides the response frequencies for the difficult driving situations that were found, in the pervious study [9], to be avoided more often by those with driving problems, namely those of driving at night, driving in the rain, and driving at night in the rain. Analysis of the differences between the levels of avoidance reported in the two studies, using the Wilcoxon Signed Ranks Test, reveals that there was a small increase in self-reported avoidance of driving at night ($z = -2.0$, $p < .05$) and that the difference between the two sets of frequencies of self-reported avoidance of driving in the rain was approaching significance ($z = -1.9$, $p = .055$).

**Table 2**: Frequencies for avoidance of three difficult driving situations, for the original and follow-up studies, N = 43

| Measure | Avoidance frequency | | | | |
|---|---|---|---|---|---|
| | Never | Rarely | Sometimes | Often | Always |
| Driving at night | | | | | |
| Original study | 32 | 5 | 4 | 1 | 1 |
| Follow-up study | 27 | 7 | 3 | 4 | 2 |
| Driving in the rain | | | | | |
| Original study | 34 | 6 | 3 | 0 | 0 |
| Follow-up study | 29 | 6 | 8 | 0 | 0 |
| Driving at night in the rain | | | | | |
| Original study | 29 | 6 | 4 | 3 | 1 |
| Follow-up study | 27 | 8 | 1 | 4 | 3 |

Table 3 provides a comparison between the two studies for participants' scores on the functional tests. Statistically significant declines in performance were seen for binocular contrast sensitivity ($t_{43} = 6.9, p < .001$), the 3MS ($t_{43} = 3.1, p < .01$) and reaction times on the CVAT primary task in both the single task ($t_{42} = -6.1, p < .001$) and dual task ($t_{42} = -6.9, p < .001$) conditions. Binocular visual acuity was also found to decline, using a Wilcoxon Signed Ranks test ($z = -2.67, p < .01$).

**Table 3**: Descriptive statistics for the functional tests for the original and follow-up studies, N = 44

| Measure | Original study | | Follow-up study | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Geriatric Depression Scale | 3.5 | 2.9 | 3.6 | 3.8 |
| State Anxiety | 30.7 | 7.5 | 30.3 | 7.9 |
| Visual Acuity, binocular[a] | 6/5 | 6/5-6/18 | 6/6 | 6/5-6/24 |
| Contrast Sensitivity, binocular | 1.8 | 0.1 | 1.6 | 0.1 |
| MMSE | 28.8 | 1.6 | 28.8 | 1.5 |
| 3MS | 96.0 | 4.7 | 94.8 | 5.6 |
| Symbol Digit Modalities Test | 40.1 | 9.0 | 39.9 | 10.0 |
| Spatial Span[b] | 12.5 | 3.2 | 14.6 | 3.4 |
| CVAT detection errors (%)[c] | | | | |
| Dual task, primary task | 4.1 | 4.4 | 6.3 | 8.9 |
| Dual task, primary task | 3.9 | 5.5 | 3.7 | 10.5 |
| CVAT reaction time (ms) | | | | |
| Single task, primary task | 423.5 | 44.3 | 507.7 | 113.5 |
| Single task, secondary task | 404.7 | 57.9 | 403.0 | 50.4 |
| Dual task, primary task | 482.8 | 50.2 | 586.9 | 119.0 |
| Dual task, secondary task | 607.2 | 104.0 | 611.4 | 91.2 |

Note: [a] Visual acuity is an ordinal variable so the median and range are provided. [b] Data were only available for 15 participants for the Spatial Span measure. [c] N = 43 for the CVAT as one participant was unable to perform the test.

Having established that there was some decline in a number of measures of vision and visual attention, but only very modest changes in self-reported driving behaviour, it was considered important to check whether there was any relationship between changes in functional ability and driving avoidance that was not evident at the level of the t-test analyses. In order to do this, change scores were calculated for all measures of driving confidence and avoidance, and for all functional tests, subtracting the scores for the original study from the scores for the follow-up study. Spearman's rho correlations were then calculated between the self-reported driving behaviour change scores and measured changes in functional ability. The only significant correlation between a measure of change in driving avoidance and change in a functional ability was between change in avoidance of right turns across traffic and change in depressive symptoms ($\rho = .33$, $p < .05$). The significant correlations between changes in driving confidence and changes in functional ability are presented in Table 4. Of most note is the fact that, of the nine correlations, there were five that indicate greater confidence was associated with poorer performance on the functional test. In particular, higher confidence when driving in the rain was associated with poorer visual acuity and lower scores on the MMSE and 3MS, and higher confidence when driving at night in the rain was related to poorer performance on the 3MS. Higher confidence when driving alone was associated with poorer reaction time but better detection error scores on the CVAT. The findings for confidence when making right turns across traffic were more positive, with higher confidence levels being associated with better scores on the MMSE and the lower detection error scores on the dual task/secondary task component of the CVAT. However, the overall picture emerging from these analyses of change scores is one that supports the results of the t-tests, specifically, that there was no clear evidence of declines in functional ability being associated wtih increased avoidance of difficult driving situations.

**Discussion**

The aim of the present study was to build on a previous study [9,10] by exploring longitudinally measured changes in functional abilities among older adults and comparing these with longitudinally measured changes in self-reported driving behaviour. It was hypothesised that declines in functional abilities would be related to increases in self-reported avoidance of difficult driving situations (i.e. greater 'self-regulation'). However, the findings indicated that there were declines in a number of functional abilities among drivers in the sample but few changes in self-reported driving behaviour. Futhermore, the small changes that were observed in self-reported driving behaviour and driving confidence did not share any clear relationship with changes in functional abilities.

Previous research into the relationship between self-regulation of driving behaviour and functional abilities has produced inconsistent results, with some finding that reduced driving and greater avoidance of difficult driving situations are associated with lower scores on measures of vision [11, 20, 21], visual attention [20] and cognitive abilities [21], while other studies found no association between self-regulation and declines in vision or visual attention [8] or cognitive functioning [22]. These studies were all cross-sectional in nature, however. The present study, by virtue of its longitudinal design, has provided data related to changes in abilities and driving behaviour, and has indicated that self-regulation does not follow from declines in functioning, although certain limitations of the study need to be borne in mind. These include the small sample size and the self-reported nature of the driving behaviour data.

**Table 4**: Spearman's rank correlations between driving confidence and functional measures, N = 44

| Driving confidence measure | Functional ability measure | $\rho$ |
|---|---|---|
| Driving in the rain | Visual acuity | .33 |
| | MMSE | -.33 |
| | 3MS | -.31 |
| Driving alone | CVAT, reaction time, single task, secondary task | .33 |
| | CVAT, detection errors, dual task, primary task | -.35 |
| | CVAT, detection errors, dual task, secondary task | -.34 |
| Right turns across traffic | MMSE | .34 |
| | CVAT, detection errors, dual task, secondary task | -.38 |
| Driving at night in the rain | 3MS | -.31 |

Nonetheless, this negative finding within a small sample of drivers does seem to be at odds with findings from an analysis of five years of police-reported crash data in South Australia [1], which revealed lower crash involvement rates for drivers aged over 65 during peak hour, night time and rain. This suggests that older drivers do reduce their exposure in these times and conditions. Therefore, older drivers are successfully self-regulating according to crash data but the in-depth analysis of a sample of older drivers presented in this paper suggests that self-regulatory practices among this age group are not consistent with functional abilities. It would therefore appear that older drivers are self-regulating and, in so doing, reducing their levels of crash involvement but that greater reductions in crash involvement would be possible if self-regulation was practised in a manner more consistent with functional abilities of the drivers.

This leads to the question of interventions to promote self-regulation among older drivers. One study in the United States that evaluated an intervention of this type [23] involved 403 drivers with a visual acuity deficit, slowed information processing, or both, being randomly assigned to a 'usual care' group or to an individualised educational intervention designed to encourage appropriate self-regulation of driving behaviour. It was found that drivers who experienced the educational intervention reported more avoidance of difficult driving situations and other self-regulatory practices than the control group but were just as likely to be involved in police-reported crashes in the two year follow-up period, even after adjusting for self-reported driving exposure. The authors concluded that the intervention did not have a road safety benefit.

Another educational intervention undertaken in the United States with older drivers recently [24] involved 40,000 drivers aged over 70 with traffic incidents on their records. Each of these drivers was randomly assigned to one of four groups. One group received educational material related to older driver traffic safety, a list of internet addresses and phone numbers related to traffic safety and ageing, a questionnaire and a letter. A second group received the list, questionnaire and letter; a third received the questionnaire and letter only; a fourth was not contacted. It was found in the questionnaire that the group receiving the educational material did exhibit greater knowledge about driver safety issues for older adults but there was no effect in the following 12 months on either crash involvement or traffic offences. The authors suggested that the intervention would need to be more intensive to have an effect [24] but the results from the study above [23] would indicate that intensive approaches similarly fail to reduce crashes despite apparent changes in behaviour. They also suggested that perhaps the rarity of crashes means that chance factors play a major role in their occurrence and interventions to reduce crash risk among a sample of drivers are unlikely to show a benefit [24].

In summary, the self-regulation of driving behaviour among older drivers was not found to be related to changes in functional abilities in a longitudinal study. Significant declines in visual acuity, contrast sensitivity and measures of visual attention did not translate into avoidance of driving situations that would be made more difficult by these declines. The sample size was small, however, and it could be that the results were also affected by volunteer bias, with those willing to be involved in a driving-related study being those less aware of problems with their driving. Additionally, the data on driving behaviour was self-reported rather than directly measured. Nonetheless, there is considerable previous research demonstrating the lack of a relationship between functional abilities and self-reported driving behaviour using cross-sectional comparisons. This would suggest that there are road safety gains to be made by intervening to encourage greater self-regulation among older drivers, especially given that crash data already indicates reduced crash involvement in difficult driving situations for older drivers. However, it does not seem, from the limited research that has been done, that educational interventions to encourage self-regulation provide any road safety benefit. Perhaps reducing exposure results in declines in skill because of a reduction in practice and so levels of crash involvement for most drivers remain the same. Further research on this topic should focus on samples of drivers with specific medical or functional impairments and measure driving exposure more directly than the self-reported measures used in the present study. In conclusion, given the contrast between the negative findings of the present study and the apparent reduced crash involvement that can be ascertained from police-reported crash data, it remains unclear to what extent self-regulation of driving behaviour can contribute to crash reductions among older drivers.

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