Shifting from manual to automatic gear when growing old: good advice? Results from a driving simulator study

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Abstract

Older people may be advised to switch from manual to automatic gear shifting, because they may have difficulties with dividing their attention between gear shifting and other driving tasks such as perceiving other traffic participants. The question is whether older drivers show a better driving performance when using automatic gear shifting instead of manual gear shifting. Twenty young and twenty older drivers participated in a driving simulator study. Each participant drove both in the manual and the automatic gear conditions. Young drivers reported significantly higher risk taking behaviour in traffic than the older drivers. The older drivers experienced more collisions in the driving simulator than the young participants, but this was only true in the manual gear condition. Older participants swerved more than young participants in both gear conditions. Altogether, the driving performance of the older drivers was better in the automatic gear condition compared with the manual gear condition. This research supports the advice for older drivers to use automatic gear shifting.

Introduction

For many people, driving is very important and their preferred mode of transport (Gruber et al., 2013). Car drivers feel they are independent and have optimal mobility options. As a result, most aged drivers continue to drive (Unsworth et al., 2007).

There is no consensus about who drive safer, young or older drivers. Actually, both young and old drivers are overrepresented in crashes (Li et al., 2003). Young drivers may show a bad driving performance due to inexperience (Isler et al., 2011) and/or increased risk taking (O'Brien & Gormley, 2013; McGwin & Brown, 1999) while older drivers may suffer from age-related changes which could compromise driving performance (Brouwer & Ponds, 1994). In older drivers, both cognitive resources (Verwey, 2000; Withaar et al., 2000) as well as their motor skills may decline (Wheatley & Di Stefano, 2008). This may explain the overrepresentation of older drivers in crashes in complex situations (McGwin & Brown, 1999). Complex situations include crossing intersections, merging and overtaking. As driving is a multifaceted task different kinds of errors can be made. Any driving behaviours that

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increase the risk of collision may be considered driving errors. Drivers show good driving performance when the number of driving errors is low, which corresponds to relatively safe driving.

Michon's model defines three levels of driving behaviour; strategic, tactical, and operational (Michon, 1985). On the strategic level planning takes place such as determining the route. On the tactical level perceiving and reacting to the environment is crucial such as keeping enough distance to others drivers. The operational level includes steering, operating the accelerator, brake, and clutch and other vehicle controls. The three levels may be active simultaneously and might influence one another. This implies, for example, that an operational level error could negatively affect driving performance on the strategic and tactical levels.

Research comparing driving performance of young and older drivers showed contradictory results (McGwin & Brown, 1999). Some researchers report that young drivers make more driving errors than older drivers (Carr et al., 1992; Shinar et al., 1998). Others demonstrate that older drivers have a worse driving performance compared with young drivers (Chaparro et al., 2005; Selander et al., 2011). Perryman and Fitten (1996) have shown that ageing may decrease operational driving skills such as maintaining a proper speed and lane position. Gear changing is another operational driving skill. Novice drivers may well find this hard and practice is necessary to learn to automatically change gears (Shinar et al., 1998). While middle-aged drivers may change gears automatically, in older drivers execution of movements may become less automatized again (Brouwer & Ponds, 1994). In the latter case, gear shifting requires attention again, thus demanding cognitive resources which are less available in older drivers. Consequently, older drivers might have difficulties with dividing their attention between gear shifting and other driving tasks such as perceiving other traffic participants (McGwin & Brown, 1999). Selander et al. (2011) reported incorrect gear shifting as fourth most common driving error in older drivers.

Older drivers may be advised to switch from manual to automatic gear shifting, but so far limited research has been performed on the role of transmission type on driving safety. Warshawsky-Livne and Shinar (2002) recorded brake reaction and movement times in a driving simulator during manual and automatic gear conditions. Reaction times increased with age, but also movement times were longer during manual compared with automatic gear shifting. The study implicates that automatic gear shifting might improve driving performance. Shinar et al. (1998) investigated sign detection by young novice drivers and experienced drivers during manual and automatic gear shifted driving. Novice drivers missed more signs in the manual gear condition than in the automatic gear condition. This difference was not found in the experienced driver group indicating that young drivers could benefit from automatic transmission. Selander et al. (2012) compared the number of driving errors made by young and older drivers during manual and automatic gear shifted driving. Here, participants in the older group showed more driving errors in both transmission conditions than their younger counterparts, but automatic transmission reduced the number of errors of the older drivers. This study supports automatic

transmission for older drivers. So far, this study has not been repeated, nor has it been performed in a driving simulator. The aim of the current study is to investigate the driving performance of young and older drivers during manual and automatic gear shifting. Swerving will be measured and the number of collisions will be counted. The hypothesis is that older drivers show more driving errors than young drivers. Also, the expectation is that participants generally will make fewer driving errors in the automatic transmission condition than in the manual transmission condition and that the performance of older drivers improves most.

Materials and methods

Participants

Overall, forty participants were recruited through distribution of flyers, advertisements and the word-of-mouth. All participants were native Dutch speakers in possession of a valid driver's license for at least one year. Twenty young and twenty older participants entered the study. One older participant was excluded, because the person did not possess a valid driver's licence. Another three older participants were excluded due to simulator sickness. Twenty young (M=22.7 ± 1.6) drivers completed the study, ten males and ten females. Sixteen older (M=73.4 ± 4.8) drivers completed the study, eight males and eight females.

Apparatus

A fixed-based driving simulator located at the University of Groningen was used for the study. The simulator consisted of an open cabin mock-up with a steering wheel, gear box, gas pedal, brake pedal, clutch and simulated driving sound. Four LED screens, three in front and one on the left of the mock-up provided the participant with a view on the road. Each screen provided a 70° view, leading to a view of 280° in total. The car windows, side mirrors and rear view mirror were realized on the screen. During driving the participants wore the safety belt. Three computers were used, one for graphical rendering, one for the traffic simulation and one for system control showing a user interface for the simulator operator. The graphical interface was designed with StRoadDesign (StSoftware) and the scenario was programmed with scripting language StScenario (StSoftware).

Procedure

Every participant drove three rides in both the manual and the automatic gear condition. Half of the young and half of the older participants started with the manual gear condition and the other half started with the automatic gear condition. In both gear conditions the same three rides were performed. The first ride was in a rural environment on a slightly winding road, the participants had to maintain their lane position on the right lane while oncoming traffic approached on the left lane. During the first part of the ride the participant chose a comfortable speed, in the second part the participant was asked to hurry and drive as fast as was just within safety margins. Participants were told there was no speed limit. The second ride was in a rural environment as well, but now the participant encountered six intersections with different priority regulations, including one with traffic lights, and also a car

that suddenly pulled out of a parking lot in front of the participant. Speed limits differed between 60, 70 and 80 km/h. The participant was told to obey the traffic rules. In the third ride the participant merged into a crowded motorway, was then asked to pass one vehicle and subsequently to leave the motorway. After the participant had driven all three rides in both gear conditions a short interview took place. The participants were asked to report their age and to reflect on their own driving competence and risk taking behaviour in traffic. Driving competence was indicated on a 10 point Likert scale running from 1 to 10 (10 being extremely competent), and risk taking behaviour was indicated on a 5 point Likert scale running from 1 to 5 (5 being very high risk taking).

Analyses

The subjective scores on driving competence and risk taking in traffic were compared between young and older drivers using t-tests. Swerving was measured as the standard deviation of the lateral position (SDLP) in cm during the first ride in both gear conditions. A repeated measures ANOVA was used to investigate differences in swerving between the manual and automatic gear conditions and between young and older participants. During the second ride in both gear conditions the number of collisions was counted. Chi-square tests were used to analyse differences in the number of collisions between both gear conditions and between the two age groups.

Results

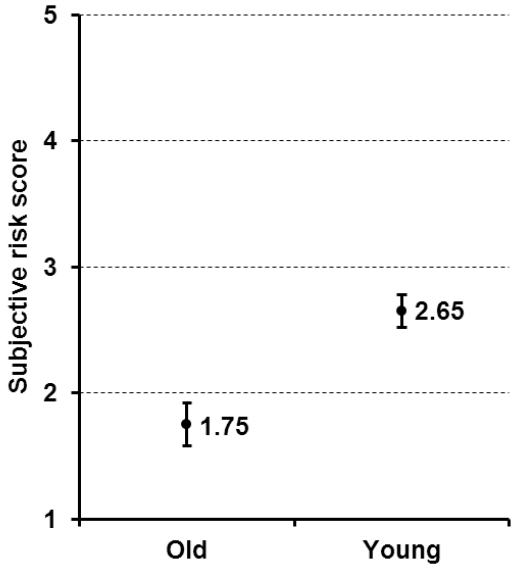

Figure 1. The subjective risk taking scores of the old and young subjects. Error bars represent the standard errors of the means.

The subjective score on driving competence is comparable in the young (M=7.30 ± 1.08) and elderly (M=7.17 ± 0.72) groups, t(34)=-0.417, NS. However, the subjective risk taking scores of older drivers (M=1.75 ± 0.68) were significantly lower compared with younger drivers (M=2.65 ± 0.59), t(34)=-4.250, p<.001 (Figure 1).

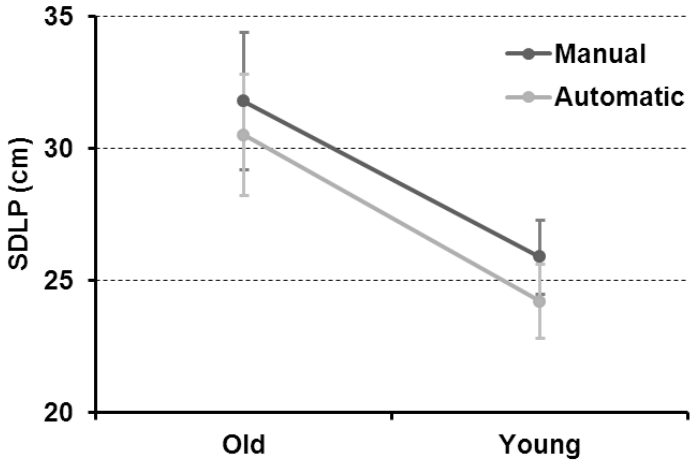

Figure 2. Swerving by old and young subjects in the manual and automatic gear conditions. SDLP = standard deviation of the lateral position. Error bars represent the standard errors of the means.

There was no significant difference in swerving between the manual and automatic condition, F(1,35)=1.08, NS. Yet, in both conditions the older participants swerved more than the young participants, F(1,35)=9.64, p=.004 (Figure 2).

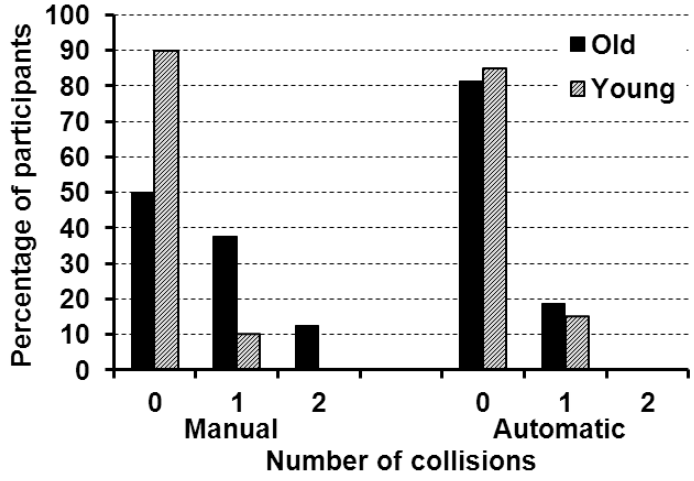

Figure 3. The percentage of older and young participants involved in 0, 1 or 2 collisions in the manual and automatic gear conditions.

Overall, there was no significant difference in the number of collisions between the manual and the automatic gear condition, χ^2(df=2, N=36)=0.62, NS. Moreover, in the automatic gear condition the young and older drivers did not differ in the number of collisions, χ^2(df=1, N=36)=0.09, NS. However, in the manual gear condition the older drivers were involved in significantly more collisions than the young drivers, χ^2(df=2, N=36)=7.49, p=.024 (Figure 3).

Discussion

Older drivers reported to take less risk in traffic than young drivers. Yet, older drivers swerved more than younger drivers in both transmission conditions. In addition, older drivers were involved in more collisions than young drivers in the manual gear condition. In the automatic gear condition this difference was not found.

The finding that older drivers take less risks in traffic compared with young drivers is consistent with previous studies (O'Brien & Gormley, 2013; McGwin & Brown, 1999). Nevertheless, the driving performance of the older drivers was worse compared with the young drivers. This may not be caused by deliberate risk taking, but by age-related changes. Older drivers swerved more than young drivers in the driving simulator. Although, the mean SDLPs were higher in the manual compared with the automatic conditions in both age groups, the variation was large and the difference between the transmission conditions not significant. Selander et al. (2012) also investigated lane-keeping control with automatic gear cars compared to manual gear cars. However, they reported older drivers to drive significantly less frequently too far to the left in an automatic car compared with a manual car. When driving too far to the left, the middle line of the road could be crossed which gives a higher risk of collision with approaching traffic. In the current study the number of middle line crossings was counted in the first and second rides in both gear conditions. In the first ride, the number of middle line crossings was significantly higher in the manual compared with the automatic gear condition, χ^2(df=16, N=36)=32.00, p=.010. This finding was, however, caused by a minority of all participants, since 22 of the 36 participants did not cross the middle line at all in the first rides. The second ride was more difficult and required more gear shifts in the manual gear condition due to the intersections. In the second rides only six out of all participants did not cross the middle line at all. Again the number of middle line crossings was higher in the manual compared with the automatic gear condition, χ^2(df=63, N=36)=99.733, p=.002. In the first ride, the difference in number of middle line crossings between the older and younger drivers approached significance, but was neither significant in the automatic gear condition, χ^2(df=4, N=36)=9.00, p=.061, nor in the manual gear condition, χ^2(df=4, N=36)=8.49, p=.075. In the second ride, the same was found in the automatic condition, χ^2(df=7, N=36)=12.11, p=.097. On the contrary, in the second ride of the manual condition older drivers did show significantly more middle line crossings than their younger counterparts, χ^2(df=9, N=36)=22.28, p=.008. Automatic transmission may thus improve lane-keeping control of, especially older, drivers.

Older drivers were involved in more collisions than younger drivers in the manual gear condition. The higher number of collisions in the older driver group may be explained by the type of collisions that could occur. Collisions were either the result of braking too late for a car that pulled out or caused by crashing into other cars at intersections. In the first case, brake reaction and movement times are crucial. Warshawsky-Livne and Shinar (2002) already reported that older drivers have slower reaction times and with manual gear shifting longer movement times arise. Together these results may well lead to an increased risk of collision as described in the first case when an older driver uses manual gear shifting. With regard to the second case, an explanation might be that older drivers have an increased risk of multiple-vehicle intersection crashes compared with young people (IIHS, 2007 & 2011). With an automatic gear older drivers no longer caused more collisions than young drivers. Young drivers were involved in as few collisions in the manual as the automatic condition. This result indicates that the older drivers were benefitting from the automatic gear shifting.

The practical implication of this research is that older drivers should be advised to use automatic gear shifting instead of manual gear shifting. To do this, one needs to know *when* a driver becomes an older driver. In the current study older participants were 65 years old or older. In the study of Selander et al. (2012) older drivers were aged between 70 and 90 years. In the study of Warshawsky-Livne and Shinar (2002) the senior group was between 50 and 82 years of age and with a mean of 62 years clearly younger than previously mentioned groups. Over-involvement in crashes is most prominent for drivers above 75 years of age (IHHS, 2007; Li et al., 2003). Therefore, a switch from manual to automatic gear shifting before the age of 75 may be advised. More research is needed to define at which age it is the best moment to switch to automatic gear. For people who have been driving cars with manual transmission all their lives it might take some time to get used to automatic gear shifting. Especially older people may experience difficulties with learning new skills. For this reason, people could be advised to acquire driving experience in an automatic gear car already at a younger age too.

Over-involvement in crashes is not only reported for older drivers, but also for drivers below 20 years of age. In all mentioned studies no groups of drivers all aged below 20 were included. A study with this group could show whether the very young drivers would benefit from automatic gear shifting too. This might be expected because Shinar et al. (1998) found that novice drivers missed more signs in the manual gear condition than the automatic gear condition.

It is of importance to investigate further for which age groups automatic gear shifting is preferred over manual gear shifting. Moreover, a longitudinal on-road study with young and old subjects may provide more insight in the number and type of collisions drivers cause in both manual and automatic transmission cars.

Conclusion

There appears to be benefit of driving a car with automatic gear for the older driver. Older drivers reported lower risk taking scores than young drivers, but showed a worse driving performance in the driving simulator. The older drivers swerved more

in both transmission conditions than young drivers. Only in the manual condition the older drivers were involved in more collisions than the younger drives. Altogether, this study supports the advice for older drivers to switch from manual to automatic gear shifting.

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