Methodological Issues When Conducting Research on Older Drivers

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Lana M. Trick
University of Calgary

Jeff K. Caird
University of Calgary

Abstract

The Problem. Older drivers are an important segment of the driving population and they are frequently included in studies that use driving simulation. There is a pressing need for research on this growing segment of the population to aid policymakers and traffic safety professionals. Role of Driving Simulators. Older drivers are disproportionately at risk for certain types of collisions. It is essential to understand the factors that endanger older drivers if their collision rate is to be reduced. Driving simulators enable researchers to reproduce the conditions associated with collisions in a safe environment. Increasingly, simulators are used to help identify older drivers at risk or evaluate the effectiveness of rehabilitation programs for these drivers. Key Results of Driving Simulator Studies. There are a variety of methodological issues to consider when conducting research on older drivers. Foremost are those that originate from the heightened incidence of simulator sickness. Moreover, in any study with older drivers, it is necessary to contend with factors confounded with age that also affect performance. Three factors are discussed in depth: driving exposure, age-related health issues, and medications. Scenarios and Dependent Variables. A number of scenarios have been investigated with older drivers, including car-following, way-finding, left turns, late yellow lights, and highway-railway grade crossings. Performance measures fall into three categories: longitudinal control (e.g., speed, lane position), lateral control (e.g., SD of lane position), hazard response time variables (e.g., perception response time), and eye movement measures (e.g., total foveal fixation, average fixation frequency, etc.). Platform Specificity and Equipment Limitations. Minimizing the number of trials and steps can reduce simulator sickness, but this restricts the scope of research questions that can be addressed. High dropout rates due to simulator sickness limit the extent that results can be generalized.
26.2 Research on the Older Driver

An exhaustive review of the literature on older drivers is beyond the scope of this chapter (for reviews, see Dewar & Olson, 2007; Dvorsky, 2007; Hultman, 2007). Instead, this section is designed to provide an overview of the types of research that involve older drivers tested in driving simulators. Although epidemiological studies of collisions involving older drivers are a useful starting point for investigating developmental influences, the research questions given emphasis and the experimental paradigms employed to answer those questions. Consequently we will begin with a brief description of the theoretical context in which these studies have been taken. Normal aging and age-related disorders complicate long-term memory (Craik & Salthouse, 2000), vision (e.g., Scalfi & Kline, 2007), hearing (e.g., Willison, Calhoun, & Lester, 2008), motor flexibility, speed, and accuracy (Madden, 2005) but not vision, hearing, and motor skills that stress attention and executive working memory dominate in the study of older drivers. Selective attention determines which aspects of the environment are noticed, information is stored and retrieved from long-term memory, and which actions are chosen from the response repertoire (for a discussion, see Tikay, Enna, Mills, & Vermik, 2004). Executive memory demands of the working memory and the prefrontal cortex are increased and speed, timed, coordinated, and prioritized (Bodley, 1993; Nielson & Burgess, 1993).

A variety of theories have been proposed to explain age differences in the performance of older drivers (Tikay, 2004). Tikay (2004) suggests that the neural changes that occur with age result in general cognitive slowing and this slowing is the source of age-related declines in performance. Hasher, Stelfas, Zacks, and Reynolds (1998) propose that specific deficits in inhibitory processing make it more difficult for older adults to inhibit distracting stimuli and irrelevant responses. Craik and Salthouse (1999) contend that age-related deficits emerge because cognitive control declines as a result of age-related changes in the brain, particularly changes in the frontal lobes. Nonetheless, it is a resource theory that appears to be the most influential in the driving literature (e.g., Resource theory: Kahanman, 1973; multiple-resource theory: Wickens, 2002). According to these theories, it is not possible to fully perceive and respond to everything at once because some resources are necessary for controlled processing. Stelfas and Schneider (1977). Controlled processes are conscious, deliberate, slow, effortful, attention-demanding processes, and because it is not possible to attend to or process many things at once (e.g., attention is a common constraint). It is possible that older drivers have special difficulty with a number of different tasks involving two or more processes at one time. How difficult is to say that the speed and accuracy of one or both will suffer. Moreover, controlled processing is necessary whenever the task is challenging, novel, unexpected and when there is access to the store of the process on-line, in response to feedback from the environment. Driving, by its nature, requires carrying out a number of different tasks at once, such as monitoring traffic and pedestrians, way-finding, planning, and decision-making (Michon, 1983), and many of these require controlled processing. From the perspective of resource theory, older drivers experience deficits in performance because they have fewer resources for controlled processing, either simply as a result of aging, or because age-related sensory and motor deficits force older adults to use cognitive resources to carry out operations that are normally carried out automatically (without controlled processing), thus reducing the resources available for other types of deliberate, attention-demanding processing (Tikay et al., 2004; see also Sensory-Cognitive Interactions), at the cost of performance. If this is the case, older adults have fewer resources for controlled processing in the traditional age groups because they contain fewer resources or because they were sacrificed more. In the face of each type of challenge, in contrast, the younger adults mainly maintain their performance regardless of the visibility, traffic density, or way-finding challenge.
cellular telephone, which has now been shown to have a deleterious effect on driving performance in a variety of different age groups (e.g., Caird, Wilness, Steel, & Scalise, 2008; Shinar et al., 2005; Strayer & Drews, 2004). Then there are the "intelligent" in vehicle technologies or telematics that is, technologies designed to be added on or even taken over entirely by the car. Navigation, night vision, and collision warning systems fall into this category. Caird (2004), Davidson (2007), and Green (2001) all review the research on the impact of these systems on older drivers, especially older drivers on rural roads. In general, older drivers may not accept these systems as readily as other drivers if they see no clear advantage to using the technology. Older drivers may also experience greater deterrents to performance as a result of design flaws that limit the usability of a given device. Furthermore, although some of these systems are explicitly designed to help older drivers, they may ultimately compromise their safety. Older adults who have given up nighttime driving may install night vision systems and once again drive at night because the systems give them additional confidence (Caird, Horrey, & Edwards, 2002). This puts them at increased risk if the system fails or if it is used in a situation for which it was not intended. Often the balance between the mobility of the individual and the safety of society is not given adequate consideration when new technologies are developed.

26.2.3 Identifying the Collision-Prone Older Driver

Another type of research focuses on finding ways to identify older drivers at risk of collision—information critical for those involved in driver assessment and rehabilitation (see also Ball & Ackerman, this book, chap. 25). Epidemiological approaches have been used to identify the demographic characteristics of high-risk groups (McGwin & Brown, 1995; Waring, 2001). Risk and protective factors or batteries of tests have also been tried (e.g., Ball, Owsley, Sloane, Roenker, & Bruni, 1993; Janse & Eberhard, 1994; Marshall et al., 2005; Mielke, Mitchell, & Marshall, 2005; Staggs, Gild, & Wagner, 2003). For example, one of the most popular attentional measures is the Useful Field of View (UFoV; Owsley, Ball, Sloane, Roenker, & Bruni, 1991; see Hoffman, McDowell, Atchley, & Dushinski, 2006 for a critical review). Simulators are sometimes used to validate these measures, and test scores are correlated with simulator and on-road driving performance (see also, Rizzo, Friedland, & Rizzo, 2003). In fact, there has been a recent move to use simulators in order to identify older drivers at risk as a cost-effective alternative to on-road testing (see, also, Rizzo, Friedland, & Rizzo, 2003). There is also a rapidly growing literature on the impact of a variety of age-related disorders on driving (Pittiruti et al., 2008; McGwin, Simms, Pulley, & Rosema, 2000; Rizzo, Reinach, McGehee, & Dawant, 1997) see also Rizzo (1999, chap 7) for a review. The effectiveness of driver rehabilitation programs for older drivers with such a history has also been assessed, and some of these studies involve simulators (see Ball & Ackerman, this book, chap. 25; Hunt & Arbesman, 2008).

26.3 Considerations in Choosing Dependent Measures for Simulator Studies on Older Drivers

A variety of different dependent measures can be used to assess driver performance and the choice of variables will in part be dictated by the research question. Investigators should be wary of ceiling and floor effects when testing different age groups no matter what dependent measure they choose. Pilot testing can help ensure that the task is neither too easy nor too difficult to reveal age differences. Dependent measures can be classified into the following general categories: lateral control, longitudinal control, response times, and eye movements. Considerations in using these measures with older drivers are outlined below.

26.3.1 Lateral Control Measures

Lateral control measures assess how well drivers maintain vehicle position within a lane. These include standard deviation of lane position, lane excursions, and deviations within a lane to increase clearance of other vehicles and road users (for example, moving left to avoid a cyclist). Lateral control measures can be sensitive to eyes off the road from distractions, perceptual-motor declines, and some cognitive declines. However, lateral control measures are also affected by the handling characteristics of the driving simulator, and the simulator vehicle may differ markedly from the one that the participant normally drives. Older drivers may have more problems adapting to these differences in handling, and this may be especially problematic when frequent right and left turns are required. Consequently, it is vital that older participants be given adequate practice so that they can get used to how the simulator vehicle handles.

26.3.2 Longitudinal Control Measures

Longitudinal control measures assess speed and headway. Speed maintenance is an essential driving skill and it can be related to tactical decisions (Milson, 1980). For older drivers, the most common pattern is to adopt slower speeds to increase available response time (Chu, 1994). Older drivers may use this strategy in order to exert some control over their circumstances and compensate for age-related increases in response time. When age-related decline is a concern, it may be necessary to adapt the speed within a given drive to sample of older drivers. In general, driving speeds are about three to five kilometers per hour slower in older drivers, but this may change depending on the posted speed limit and the type of roadway (e.g., see this book, chap. 16 by Milroy and Caird describing external distractions, and the chap. 39 by Caird et al., describing railway-crossing conditions). Because fewer perceptual cues to speed are available to a simulator older driver (e.g., Strayer & Drews, 2006). Complications emerge when this scenario is used with older drivers. Because older drivers often adopt larger following distances than younger drivers, they may avoid a collision with an upset driver even though this may lead to an increased rear-end crash. Braking (see this book, chap. 16 by Milroy & Caird, "External Driver Distractions: The Effects of Video Billboards and Wind Pumps on Driving Performance"). Another way to measure performance on this task is to assign minimum headways. How close the driver comes to a lead vehicle when it brakes (Caird, Chibalin, & Locatisi, 2008).

26.3.3 Reaction Time Measures

The tendency to respond to sudden hazards that emerge from the periphery: pedestrians, cyclists, or vehicles that travel into the path of the driver. Response times can be measured in different ways. For instance, if a pedestrian walks into the roadway, reaction time could be defined as the time from the appearance until the eyes of the driver land on the pedestrian. More commonly, perceptual response time (PRT) is defined as the time from first appearance of the hazard until the driver places his or her foot on the brake. Perception and response time can be further fractionalized. Perceptual time is the time from appearance of the hazard until the driver removes his or her foot from the accelerator and response time is the length of time from keeping the brake until placing it on the brake (Olson & Farber, 2003). PRT is used to determine whether drivers can respond adequately to traffic control devices, signs, and road geometry, and it is an essential component of many design assumptions (e.g., see Stapp et al., 1998). Accident reconstructionists use PRT to determine if a driver could have avoided a crash if they had exercised adequate reaction and attention when a crash has occurred. Estimated PRT will also give an indication of certain distributions are used to infer proportional bias (Olson & Farber, 2003).

A variety of other reaction time measures require drivers to respond to the appearance of a probe stimulus, for example, the sudden illumination of a light-emitting diode within the vehicle (Lamb, Kasaara, Lakso, & Tummaa, 1996). In this type of study, participants are required to do two things at once: drive (the primary task) and monitor (the secondary task). The primary task is evidence that older drivers try to stop with more precision than younger drivers and, in general, older drivers may be more inclined to value accuracy over speed. It is important to consider this possibility when designing instructions and, if possible, it may be beneficial to try to assess whether participants are using different emphasis on speed or accuracy—perhaps with a post-test questionnaire.

26.3.4 Eye Movement Measures

An obvious way to measure differences in driving performance is to look for age-differences in collisions, but collisions are relatively rare and, as a result, perceptual response times are often measured in laboratory studies (Brown & Hertwig, 2000, chap. 5). There are a variety of different response time measures, and different issues emerge depending on the event that gives rise to the response. For example, one common scenario requires drivers to respond to lead vehicle braking (e.g., Strayer & Drews, 2006).

It has become increasingly common to use eye movement systems in driving simulator studies, but there are a number of programmatic considerations that mean that there are even more eye movement studies when testing older drivers. First, the eye tracking...
26.4 Methodological Challenges

In this section we will first focus on general issues of reliability and validity when testing older drivers, and then discuss complications that emerge due to the higher incidence of simulator sickness in older drivers. (This is known as "simulator sickness" among older drivers)

26.4.1 Reliability

When conducting research it is important to strive for reliable measurement tools: more that yield consistent results across repeated assessments of the same individual. However, the performance of older drivers is more variable across different times than younger drivers (Wall, 1999). This means that an older driver may perform very well on one occasion and much worse on another, even if the measurement technique is deemed reliable when used on younger populations. This increased variability over time may originate from several sources. Age-related health conditions may produce marked day-to-day fluctuations in how older participants feel. In addition, many older adults experience periodic problems getting a good night's sleep, and fragmented sleep has been shown to have deleterious effects on cognitive abilities (Oosterman, Van Sumeren, Vogels, & Scherder, 2009).

This increased variability across time in older drivers is a problem if a researcher wants to use a given driver's performance on one day as a valid predictor for performance in the future. For example, as occurs in studies that endeavor to identify collision-prone drivers (Wall, 1993) because it undermines the correlations between time one and time two performances. Depending on how the study is designed, it can also be a problem in studies of age differences or studies of the effects of road design or in-vehicle technologies on the older driver. Many of these studies involve analyzing very small time periods (within-subject, repeated measures) manipulations in addition to the age comparison. In a repeated measures manipulation, each participant experiences every condition of the independent variable, and thus the time required per participant increases with the number of factors thus knowing the total fixation duration or the total length of time extracting information from a location necessarily tells you about an older driver's, a disease, a roadway modification or technology? Are there precedes of eye movements that can provide insight into the same question without incurring the same time cost? For example, when testing the impact of using a new in-vehicle interface, it may be as effective to measure time to task completion (time to use the interface) or an aspect of driving performance (e.g., stopping accuracy).

If a researcher is not deterred by our warnings, a variation of Experiment 2 in Figure 2.2 illustrates that fixation frequency and duration are common. Definitions of these measures can be found in Green (2007). Older drivers typically look at an object longer and more frequently to extract the same informal information as younger drivers (Hs, Scalfa, Alpert, & Caceci, 2001). In addition, older drivers look at a sign later (when they are in closer proximity) given restrictions to legibility—a feature that may be more pronounced when testing in conducted in a driving simulator (see, Kuklis & Dewar, 2004; Caird et al., this book, chap. 38).

26.4.2 Validity

When age differences are found, it is often unclear whether these differences are the result of age per se or of variables confounded with age. For example, the study by Aitken et al. (2007) that we used to test younger participants who match the older drivers in terms of the confounding variable(s). For example, it is to screen out drivers if their scores do not fall within a certain range on the confounding variable(s). However, it is frequently difficult to find younger participants to match older drivers and screening increases time and costs incurred in acquiring samples. Rather solution reduces the representativeness of the resultant samples and thus limits the external validity of the research findings. This solution involves using statistical controls such as regression or analysis of covariance to partial out the effects of confounding variables. Pulling that, at the very least, the confounding variables should be reported and conclusions qualified accordingly. In other cases, the solution is to measure the confounding variables. In the following section we discuss three classes of variables that are a cause for concern.

The first, and arguably the most troublesome, is differential exposure. Older drivers do not drive as often or as far as younger drivers. It is likely to avoid driving in challenging conditions (Bruns, 2006; Urrutia, Ropp, Browning, Thomsen, & Hall, 2007). It has been argued that differential exposure underpins age differences in collision rates (Hamers, Boomsma, Palmgren, Annet, 2004; Langford, Methorst, & Hamers, 2010). Also, in previous generations, men did the majority of driving (Hamers, Boomsma, Palmgren, & Hall, 1993). Some older women do not start driving on a regular basis until their husbands no longer drive. This means that some drivers though they may have been licensed for many years. Driving is a complex task that demands coordinating multiple tasks, including steering, controlling velocity, detecting hazards, and responding to signals, traffic control devices, and driving challenges such as slippery roads and bad weather. With regular practice, some of these tasks can become automatic, or "effortless", and can be performed without conscious effort or monitoring with other ongoing processes (Shiffrin & Schneider, 1977). Some components of driving may take up to five years of practice to become fully automatic (e.g., Gregor, 2000; Stittar, Meit, & Ben-Shlomo, 1998). However, present day aging drivers are more affected on the frequency and recency of practice (Trick et al., 2004), and if older drivers do not drive on a regular basis they may have to use effortful deliberate (controlled) processes to carry out tasks that were once automatic.

As a result, it is useful to gather detailed information about the frequency, recency, and the regularity with which drivers use their cars before making strong conclusions about age-related effects. Self-report measures are often used to assess exposure, such as the number of kilometers driven over a certain time interval (a week, a month, or a year). Unfortunately, self-reports of driving behavior may not be reliable (e.g., Kuklis & Dewar, 2006; Maran & Lavelle, 2005). Drivers may not have a clear idea of how far they have traveled. Some studies use GIS technologies or electronic devices such as the CarChip to assess exposure (e.g., Schuurman, Porter, & Marsh, 2006; Marsh, Artz, & Winters, 2007) but in many cases, this is not feasible and thus self-report measures may be the only practical alternative. Some investigators request participants to keep detailed driving diaries over a period of time, though this increases the time and costs of data collection and may confound the optimal way to design self-report measures to ensure the most accurate estimates for the amount and type of driving exposure. A minimum yearly travel distance should be considered as a screening criterion, unless distance traveled per year is the basis of a central research question.

A second problem originates from difficulties in distin- guishing the effects of aging from those of other age-related disorders. There are a variety of such disorders, including cataracts, macular degeneration, glaucoma, diabetic retinopathy, heart disease and stroke, sensory-neural deafness, dementia of various kinds, and arthritis (see Ritter, this book, chap. 46). At the very least, researchers should include a question- naire to assess general health. Unfortunately, participants are not always aware that they have an age-related disorder which compromises their ability to perceive and react to the challenges of the driving environment. For this reason, researchers often include measures of health (e.g., Wallace & O'Gorman, 2008). Of the many screening tests (e.g., Brains, 2005; Gilmore, 2002). Many perceptual disorders affect color vision, and deficits in color vision can compromise a driver's ability to detect signs or react to hazards. Given that it is often necessary to distinguish between problems related to age and those related to underlying disease, it is important in these domains to assess the value of new assessments (e.g., the Ishihara color plates (Ishihara, 1993). Cognitive status is often assessed using tests such as the Mini-Mental State Exam (MMSE), Boston, Folstein, & McHugh, 1975). However, for more comprehensive testing (Shy, Mason, Shope, and Dellinger [2007] suggest a battery of 17 measures that might be useful when con- ducting longitudinal studies of older drivers, when it is criti- cal to evaluate changes that occur in performance. The battery takes about an hour to administer, and it measures vision, attention, motor performance, and cognitive status (see also Danson, Anderson, U. Dzientr, & Binn, 2005).

The third problem originates from the fact that many other older adults take one or more prescription drugs which may impair driving (e.g., Rapoport & Bainis, 2005; Luciano & Stipanovic, 2010). It is more usual that the specific effects of the medications they are using to the testing session. Participants may be excluded if they are taking a drug that is known to adversely affect driving, such as cyclic antidepressants (Willis, Ginnis, & Moeb, 2001). Doctors and pharmacists do
neural transmission of patients side-effects. However, in many cases the effects of drugs and drug interactions on driving per-
formance are unknown.
When reporting the characteristics of the sample, it is also a good idea to include information on age (mean and standard dev-
iation), gender, education, types of licenced vehicle (car or truck), and whether the sample contains commercial drivers.
Moreover, it is useful to measure crash history and moving vi-
olations, though too those variables there may be biases in self-
reporting (Adamos, 2005; Owlely, 2004). Information on crashes and moving violations may be obtained from insurance com-
panies and government licensing agencies but, when using these sources, it is important to recognize that many crashes and
violations are not reported. There may also be institutional
biases among the authorities judging who is at fault. Access to
databases involves overcoming privacy and bureaucracy issues.
Overall, it is essential to remember that older drivers are not
a uniform group and notable changes occur between the ages of
60 and 90 years, in transition from the "young-old" to "old-old." As
well, there is more biological diversity among samples of the same
chronological age for older than younger adults (Wallier, 1991).
In any given study, there is a danger that the sample may not
be truly representative of the general population of older
drivers because of how the sample was obtained. That is
why it is a good idea to specify how the sample was recruited (from
newspaper ads, booths at seniors’ recreational centers, senior’s
residences, hospitals, etc.). Selection bias may be a factor unaf-
fected in observational testing of older drivers. Simulated drivers
may be especially good drivers, or ones who are exceptionally
confident about their driving. Even then, we have observed that
many older drivers are very concerned about having their driv-
ing performance evaluated and before they agree to participate
they may require additional assurances that information about
their performance will not be shared with licensing agencies.
26.4.3 Simulator Adaptation Syndrome
There are many types of simulator, ranging from desktop models
to those that involve car bodies and moving bases that support
six-degrees-of-freedom motion (see Greenberg & Blommer, this
book, chap. 7) but when simulators are used, there is the risk of
simulator adaptation syndrome, colloquially known as "Simula-
tor sickness." When a participant has simulator adaptation syn-
drome they experience one or more of the following symptoms:
disorientation, dizziness, headache, stomach discomfort and
nausea. If this occurs, testing may have to be halted for ethical
reasons.
The exact prevalence of simulator sickness is unknown because
dropout rates are seldom reported (see Stoner, Fisher, & Mott, 1990). The adaptation syndrome can be indicative of situa-
tions that the incidence is especially high among older adults.
Several years ago, the second author contacted a variety of insti-
tions including the University of Minnesota, INRETS, the
Technische Hochschule in Aachen, Germany and University of Iowa
asking about dropout rates for older drivers due to simulator
adaptation syndrome. Estimates ranged from 30% and 75%, with
one study concluding that 50% of drivers rated their experience
inconsistent from study to study for a number of reasons, but older
drivers and females seem to be especially at risk. For example,
Caird et al. (2007) found that drivers over the age of 65 com-
pared with 56% of drivers aged 55 to 64, and 29% were aged
18 to 35). Of the dropouts, 85.7% were women. In the fol-
lowing sections we discuss issues that arise due to the incidence of
simulator adaptation syndrome.
26.4.3.1 Screening and Monitoring
Screening is a crucial first stage when conducting research on
gerder using driving simulators. To begin with, it is a good idea
to screen for cognitive status because it is critical that partici-
pants fully understand the risks of simulator testing before they
consent to participate in the study. In community samples, where
participants give their own consent, we require MMSE scores of
26 or higher to complete 30 to simulate in a participant study.
(Most volunteers easily surpass this criterion.) Then there are
questions designed to identify and screen out indi-
viduals at risk of simulator sickness (the Simulator Sickness
Questionnaire: Kennedy, Lane, Berbaum, & Liiinthal, 1995; Test
of Postural Stability; Staffa-cen, Palagayan, Bardy, & Hetingter,
2000). Generally, we define as "high-risk" any number of pa-
tients who experience simulator sickness in a given study, but
these tests do not have perfect predictive validity. Conse-
sequently, there will be people who pass the screening tests and nonetheless develop simulator sickness.
Thus, some of the recruited sample will be excluded in the
screening process. Others will be excluded when they develop
simulator sickness during testing, there is a danger that the
remaining sample will no longer be representative of the popula-
tion of older drivers (if it ever was). In fact, there is a pos-
sibility that the excluded participants are the very ones that most
need to be studied. For example, crash risk is related to falls and
vest-
tibular disturbances (Vance et al., 2006). Vestibular disturbances
can produce postural instability and one common screening test
screens out participants based on postural instability (the Test of
Postural Stability; Staffa-cen, Palagayan, Bardy, & Hetingter,
2000). This does not negate the importance of research on the remainder of the participants, but it means that researchers should acknowledge that there are
drivers whose problems they cannot address. Because high drop-
out rates limit the generalizability of the findings, it is important to
document the incidence of simulator adaptation syndrome.
In fact, if progress is to be made in developing better screens to
iden-
tify those at risk of simulator sickness, in addition to recording
characteristics of the sample, it is critical to keep records on the
characteristics of those that were dropped from the sample. Information about predictors of simulator adapta-
tion syndrome can be instrumental in developing better screens.
When designing studies in which the use of simulators is
essential due to uncertain driving performance, there are several
ethical issues that should be taken into consideration when choosing dependent variables to best assess their driving performance.

26.4.3.2 Mitigating the Risk of Simulator Sickness Through Scenario Design
A variety of techniques have been used to prevent simulator adaptation syndrome, including reducing the room temper-
atures, using a fan to circulate fresh air, decreasing the luminance
of the projections, providing a horizon line for participants to look
at, having participants wear braclets on pressure points on
the wrists, and giving them more time to acclimate to the simulator (see Stoner et al., this book, chap. 14, for a compre-
ensive discussion of the most effective interven-
tions involve changing the nature of the simulated drive: that is, limiting the number of stops and turns and reducing the field of view.
Unfortunately, restricting the drive in these ways may make it
difficult to observe age differences in performance. Crash rec-
cords reveal that older adults are especially at risk at intersec-
tions (Preston et al., 1986). In test drivers at intersections
without giving them a wide field of view and opportunities to stop and turn. There are issues of reliability in measurement
when the numbers of stops and turns are minimal. Perception
response time is one of the most common indices of driving per-
formance (Ohren & Tubet, 2003) and most response time mea-
sures require braking. In the laboratory research on attention, it is
stated that participants must at least require at least 10 replications per data point to ensure reliable response time data. Therefore, reliable response
time data requires multiple braking events but simulator studies
cannot afford to have a large number of braking events in a short
period of time (risk of simulator adaptation syndrome to unacceptable levels. (There also is the danger
that drivers may become sensitized if there are too many events per
drive (Gaidh, Chisholm, & Lockhart, 2008)). Similar to,
study drivers in different environments (e.g., desired destination using signs and landmarks, e.g., Pick, et al., 2009), it is necessary to give
drivers choice points where they have opportunities to turn. It
is also important to consider the correction that will be necessary if drivers miss their designated turn. To obtain reliable way-finding data it may be necessary to provide drivers with a number of such
decision points, but each turn (required or committed in error)
increases the probability of simulator adaptation syndrome.
Thus, in designing scenarios, the judges of simulator sickness and
reliability are bought at the expense of augmented risks of simulator adaptation syndrome. It is possible to reduce these risks by extending testing over several days (rather than concentrating it in one session), but just testing older adults and
with multi-session studies there is always a danger of attrition,
and variability across time (see section on reliability). When testing older adults, it is often necessary to wrestle with a variety of conflicting tasks and variables that promise
can be made: ways to minimize the risk of simulator adaptation and yet keep a reasonably wide field of view; ways to study interactions and yet reduce the number of stops and
turns (see Stoner et al., this book, chap. 14). Researchers
should familiarize themselves with these techniques and use
them when they can. However, before they undertake an inves-
tigation, it is critical that they realize that the research ques-
tion is of adequate importance and their project sufficiently
well planned to justify the enhanced risk of simulator sickness
for older participants. This means a thorough literature review
and careful pilot-testing.
26.5 Conclusions
Simulator studies have yielded valuable insights into the per-
formance of older drivers and this research has significant implications for both theory and practice. However, there are
methodological challenges inherent in testing older drivers and
additional complexities emerge when these studies involve driv-
ing simulators. This research requires patience, logistic support,
and a research plan. Investigations are likely to take longer than expected. It may take many months to gather an adequate sam-
ples given the dropout rate and the number lost to screening and
simulator adaptation syndrome. Furthermore, each individual
testing session may take longer than anticipated because of the
older drivers like to talk before, during, and after the study. It
has been our experience that older drivers are very concerned
with driving safety and they have many valuable insights about problems they encounter or are in other drivers. As a result, it is
especially important that researchers listen and observe. There
is much to be learned.

Key Points
- Research on older drivers is essential to policymakers, professionals involved in testing and rehabilitating older drivers, and those involved in designing and evaluating new driving environments and in-vehicle technologies.
- A variety of factors threatens the reliability and validity of research on older drivers. It adds to a number of issues to be taken into consideration when choosing dependent measures to best assess their driving performance.
- The variability among individuals of the same chronological
age is higher among older than younger drivers. It is important to record participant characteristics, including health, medications, visual acuity, cognitive status, and driving exposure.

- The prevalence of simulator sickness is higher among older than younger adults. Measures can be taken to reduce simulator sickness but nonetheless it is sometimes necessary to drop participants from the study because they are experiencing symptoms. The remaining sample may not reflect the general population of older drivers.

Keywords: Aging, Age-Related Decrement, Lifespan Driving, Older Drivers, Simulator Sickness

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Key Readings


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