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Age differences in simulated driving performance: Compensatory processes

E.C. Andrews*, S.J. Westerman

Psychology of Design Group, Institute of Psychological Sciences, University of Leeds, LS2 9JT, United Kingdom

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ABSTRACT

In the context of driving, the reported experiment examines compensatory processes for age-related declines in cognitive ability. Younger (26–40 years) and older (60+ years) participants ($n = 22$ each group) performed a car following task in a driving simulator. Several performance measures were recorded, including assessments of anticipation of unfolding traffic events. Participants also completed a range of measures of cognitive ability – including both fluid and crystallised abilities. Three examples of age-related compensation are reported: (i) older drivers adopted longer headways than younger drivers. Data were consistent with this being compensation for an age-related deficit in complex reaction time; (ii) older drivers with relatively higher cognitive ability anticipated traffic events more frequently, whereas the reverse pattern was found for younger drivers; and, (iii) older drivers with greater crystallised ability were less reliant on spatial ability to maintain lane position. Consistent with theories of 'cognitive reserve', interactions between crystallised ability and age for self-report workload suggested that compensation for age-related cognitive ability deficits required investment of additional effort. Results are considered in the context of the prospects of further assessment of older drivers.

1. Introduction

As the population in the developed world is aging (Cohen, 2003) so the number of older drivers is increasing. Given well documented age-related declines in perceptual and cognitive abilities (e.g. Birren and Schaie, 2006; Salthouse, 2010) this pattern of demographic change has been a cause of concern and prompted consideration of driving assessments and restrictions for the elderly (Department for Transport, 2001). However, the effects of aging on driving safety are complex and a large proportion of older drivers maintain a high standard of performance (Dobbs et al., 1998; Hakamies-Blomqvist, 1998). Moreover, driving is an important social and 'self-care' facility for many elderly people (Chipman et al., 1998; Department for Transport, 2004; Oxley and Whelan, 2008). Therefore a detailed understanding of the nature of age-related declines in driving performance is required. In this paper we contribute to this with a simulator study of compensatory processes that may be employed by older drivers – i.e. means by which this pattern of decline can be ameliorated or eliminated. We extended previous work in this area by testing for different patterns of association between cognitive abilities and driving for younger and older age groups as possible indicators. We limit ourselves to considering the 'normal' process of cognitive aging and do not include effects of visual acuity or physical impairments.

1.1. Age-related changes in cognitive ability and driving performance

When considering cognitive aging an important distinction has been identified between ability clusters described as 'fluid' and 'crystallised' (Horn and Cattell, 1967). Fluid abilities (e.g. problem-solving, complex reaction time, reasoning, spatial abilities) allow one to respond speedily to novel tasks where it is not possible to rely on prior learning or knowledge. In contrast, crystallised abilities reflect acquired knowledge (e.g. knowledge of language, culture and other life experiences). Fluid abilities are subject to a steady decline from early adulthood, (see e.g. Birren and Schaie, 2006; Salthouse et al., 1998). Different causal mechanisms have been proposed to explain this, including age-related reductions in processing resource capacity, reductions in processing speed (Salthouse, 1991), deficiencies in inhibitory processing (Hasher and Zacks, 1988) and increases in neural noise (Welford, 1981). In contrast, crystallised abilities are maintained or even increase into old age.

This age-related decline in fluid abilities has led many to the conclusion that there will be a correlated age-related decline in driving performance. However, the position is not so clear. When crash frequency is corrected for exposure (miles driven), older drivers have increased risk compared to all but young, relatively inexperienced drivers (Williams and Carsten, 1989). But this

* Corresponding author. Tel.: +44 7730654225.
E-mail addresses: E.C.Andrews@leeds.ac.uk, liz@icing.fsnet.co.uk (E.C. Andrews).

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