Transportation Research Part F 40 (2016) 156–168

Contents lists available at ScienceDirect

Transportation Research Part F

journal homepage: www.elsevier.com/locate/trf

Situation Awareness: Its proficiency amongst older and younger drivers, and its usefulness for perceiving hazards

C.E.J. Key [a,*], A.P. Morris [a,1], N.J. Mansfield [b,2]

[a] Loughborough University, Design School, Epinal Way, Loughborough, Leicestershire LE11 3TU, United Kingdom
[b] Imperial College London, Faculty of Engineering, Dyson School of Engineering, 10-12 Prince's Gardens, South Kensington Campus, London SW7 2AZ, United Kingdom

ARTICLE INFO

Article history:
Received 13 August 2015
Received in revised form 9 December 2015
Accepted 17 April 2016
Available online 19 May 2016

Keywords:
Situation Awareness
Hazard Perception
Older drivers
'Think Aloud' method

ABSTRACT

The two studies reported here sought to measure and compare the Situation Awareness (SA) of younger and older driver groups whilst driving (Study 1), and watching video footage of actual car journeys (Study 2). In both studies this was achieved by recording a participant's commentary on what s/he felt was of relevance to the driving task. The narratives produced were analysed by computer software that could abstract main concepts and calculate scores indicative of Situation Awareness. In Study 2, these scores were related to others for hazard perception proficiency (also derived from participant commentaries). It was found that the older drivers matched and often exceeded the younger drivers when their SA scores were compared individually, but not when assessed as a group. However, the younger drivers out-performed their older counterparts in hazard perception ability, and this was shown to be related to their Situation Awareness score. When the results from participants who undertook both studies were compared, it was found that Situation Awareness performance was significantly higher when commenting on video footage (Study 2) than whilst actually driving (Study 1).

1. Introduction

1.1. Rising older driver population

With continuing advances in health and medicine, people are generally living longer. In the UK it is estimated that by the year 2031 almost 23% of the population will be over 60 (Office for National Statistics, 2010). As the population has aged, so the number of older drivers has risen. Around 52% of those aged 70 and over currently hold a driving licence (Box, Gandolfi, & Mitchell, 2010), and the expectation is that the number of drivers in this age group will rise faster than any other (e.g. Box et al., 2010; Burkhardt & McGavock, 1999; Lyman, Ferguson, Braver, & Williams, 2002).

* Corresponding author. Tel.: +44 (0)1582595440.
E-mail addresses: J.Key@lboro.ac.uk (C.E.J. Key), A.P.Morris@lboro.ac.uk (A.P. Morris), neil.mansfield@imperial.ac.uk (N.J. Mansfield).
[1] Tel.: +44 (0)1509226981.
[2] Tel.: +44 (0)20 7594 8853.

http://dx.doi.org/10.1016/j.trf.2016.04.011
1369-8478/

1.2. Age and driving

This increase in older drivers has also been matched, albeit to a lesser degree, by other age groups, fomenting predictions that road traffic accidents will be the sixth most prevalent cause of global deaths by the year 2020 (Jacobs, Aeron-Thomas, & Astrop, 2000). This has led to concerns with regards to older drivers for three principal reasons:

(a) There are a range of age-related physiological, perceptual, and cognitive declines (e.g. Damos & Wickens, 1980; Korteling, 1993; Laux, 1995; Lorsbach & Simpson, 1988; McDowd & Craik, 1988; Salthouse, 1985; Schneider & Fisk, 1982; Smith & Earles, 1996; Tun & Wingfield, 1997) that may negatively affect their driving performance, and therefore road safety. Examples include slower motor responses (Rinalducci, Smither, & Bowers, 1993) and poorer judgement of gaps (Darzentas, McDowell, & Cooper, 1980).
(b) Police reports and insurance data show older drivers are more likely to be considered responsible for the accidents in which they are involved (Langford, Koppel, Andrea, & Fildes, 2006), and that they tend to involve multiple vehicles and more serious injuries (Department for Transport, 2004; Morris, Welsh, Frampton, Charlton, & Fildes, 2003).
(c) Older individuals are more likely to suffer serious injury and are at more frequent risk of being fatally injured as a result of an accident – in the region of 2–5 times more than that of a younger person – due to their physical frailty (Department for Transport, 2004). They are also likely to take far longer to recover from their injuries, in comparison to younger accident victims (see Platts-Mills et al., 2015).

1.3. Situation Awareness and driving

Situation Awareness (SA) which most often has been defined as "the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (Endsley, 1988, p. 97) has relevance for driving safely. It enables us to explain how drivers can combine long-term goals (such as reaching a destination), with short-term goals (such as slowing down for a junction) as they drive (e.g. Sukthankar, 1997). To achieve SA, a driver is said to employ a range of cognitive processes, including perception and pattern recognition (Kass, Herschler, & Companion, 1991), attention and comprehension (Kass, Cole, & Stanny, 2007; Wickens & Hollands, 2000), and decision-making (Endsley, 1995b; Ma & Kaber, 2005). These processes are about conscious recognition and comprehension of a meaningful event (e.g. a roundabout is approaching, so traffic may appear from the right (in the UK)). And as the number of these events increase, how such information excesses are dealt with will much depend on how attention is distributed: both within tasks (e.g. when a driver determines what to concentrate on); and across tasks (e.g. when s/he divides attention among multiple tasks, such as interacting with in-car technologies).

As such, a lack of, or inadequate levels, of Situation Awareness are said to constitute a primary factor in accidents attributed to human error (Hartel, Smith, & Prince, 1991; Merket, Bergondy, & Cuevas-Mesa, 1997; Nullmeyer, Stella, Montijo, & Harden, 2005). Indeed, Gugerty (1998) points out that "errors in maintaining situation awareness are the most frequent cause of errors in real-time tasks such as driving" (p. 498) and that poor SA can be attributed to more accidents than improper speed or technique.

1.4. SA and older drivers

In view of the perceived onerous nature of information processing that is essential for good Situation Awareness, unsurprisingly perhaps, the performance of older drivers has become increasingly scrutinised due, as noted above, to the rapid expansion of this driver group, and a growing awareness of age-related cognitive, perceptual and physical declines.

SA researchers have sought to assess how ageing impacts on a driver's ability to attend to important information in driving environments of different complexity. Generally it has been found that older drivers demonstrate poorer SA (e.g. Bolstad, 2001; Kaber, Zhang, Jin, Mosaly, & Garner, 2012; Zhang, Jin, Garner, Mosaly, & Kaber, 2009). However, there are studies that have found similar (poor) levels amongst young drivers (Bolstad, 1996), changing SA performance according to environment conditions (e.g. rural, urban, hazards: Zhang et al., 2009), and in Bolstad and Endsley (1991), no age effects at all.

Situation Awareness is said to develop with driving experience (Lee, Olsen, & Simons-Morton, 2006; Randel, Pugh, & Reed, 1996). There are also observed correlations between SA, driving experience, and safer driving (Soliman & Mathna, 2009), but such associations have not been found specifically for older drivers. Overall, much of the above ambiguity as to the influence of SA on older (and younger) driver performance is due to insufficient research.

The purpose of the two studies reported here was to firstly investigate whether older drivers do indeed demonstrate poorer SA when assessed against a younger driver group: whilst actually driving (Study 1); and/or when viewing a driven car journey (Study 2). Secondly, to consider SA differences among those participants who undertook both of these studies, and finally, to assess whether SA might be a predictive factor for scoring on a driving proficiency indicator – hazard perception (Study 2).

1.5. SA and hazard perception

This measure was chosen for Study 2, firstly as it has been correlated with traffic accident involvement reporting (e.g. Darby, Murray, & Raeside, 2009; McKenna & Horswill, 1999; Quimby, Maycock, Carter, Dixon, & Wall, 1986; Wells, Tong,