Accident Analysis and Prevention 117 (2018) 239–249

Contents lists available at ScienceDirect

Accident Analysis and Prevention

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

Driver distraction by smartphone use (WhatsApp) in different age groups

Ortiz C.*, Ortiz-Peregrina S., Castro J.J., Casares-López M., Salas C.

Department of Optics, Laboratory of Vision Sciences and Applications, University of Granada, Granada, 18071, Spain

ARTICLE INFO

Keywords:
Smartphone
WhatsApp
Visual function
Driving performance
Distraction
Age

ABSTRACT

This paper investigates the effect that texting with WhatsApp, one of the most common applications for instant messaging, exerts on driving performance. Because distracted driving also affects older drivers, who can have seriously compromised vision, we also analysed the associations between visual-function parameters and driving performance. A total of 75 drivers, experienced in sending WhatsApp messages (≥10WhatsApp messages/week), participated in this study and were divided into four age categories. Visual-function tests included contrast sensitivity with and without glare, retinal straylight and objective assessment of optical quality. Simulated driving performance was assessed under a baseline driving condition (without distraction) as well as a texting condition (WhatsApp messages) while driving. The participants used their own mobile phone. Lastly, objective results of driving performance were compared with subjective self-report data from the Driver Behaviour Questionnaire (DBQ). The analysis indicated that functional changes occurring with age, such as a lower contrast sensitivity and greater retinal straylight, were correlated with a higher number of collisions, longer distances driven outside the lane, and greater standard deviation of lateral position (SDLP). The results showed a significant main effect of age for the driving-performance parameters. Also, compared to the baseline, texting WhatsApp messages while driving worsens driving performance for all age groups, most notably among older participants. Thus, the older drivers' SDLP was ~14% higher than that for the baseline average of all the other drivers and rose to 29% under distraction, reflecting the impact of secondary tasks. The negative effect of the use of the smartphone during driving was also reflected in the number of collisions, with a greater risk of accidents in all the groups of drivers (by 8.3% for young adults, 25.0% for adults, 80.5% for middle-aged adults, and 134.5% for older drivers). Lastly, participants' subjective responses indicated that younger drivers (18–24 years) had a higher risk of deliberately violating safe driving practices ($p < 0.05$). The present study demonstrates that texting WhatsApp messages while driving significantly impairs the ability to drive safely, with older drivers being the group most adversely affected. It would be recommendable to include other nonstandard vision tests, which have shown associations with driving performance, in the examination for driver licensing. This would help raise the awareness of older drivers concerning their visual limitations, permitting them to adopt compensatory measures to improve their driving safety. Nevertheless, it is also necessary to raise awareness among the younger drivers of the risks involved in behaviour behind the wheel.

1. Introduction

Distracted driving is one of the major concerns in terms of road safety today. According to the Spanish General Directorate of Traffic (DGT), 35% of fatal crashes were caused by driver distraction in 2015 (Dirección General de Tráfico, 2016). In Canada, data from 2003 to 2007 showed that 10.7% of all drivers injured were distracted at the time of the crash (World Health Organization, 2011). Data from NHTSA's Fatality Analysis Reporting System (FARS) indicated that, in the United States, 10% of all fatal crashes and 15% of injury crashes in 2015 were reported as distraction-affected accidents (Report No. DOT HS 812 381). This level seems to persist.

One of the main causes of driver distraction is mobile-phone use, mostly for texting (Wilson and Stimpson, 2010). Until a few years ago, driving distraction from phones was limited to calls or SMS (Short Message Service). However, it has changed with the smartphone's emergence. Smartphones enable us to access the Internet, check e-mails, and social media or converse with applications such as WhatsApp, one of the most common applications for instant messaging at no cost. The growth of this application has been exponential since its introduction only eight years ago, reaching 1 billion users (https://whatsapp.com). In Spain, according to DGT, 89% of all smartphone owners use WhatsApp in their devices and 53% use it occasionally for texting while driving, despite this practice being banned (Dirección

* Corresponding author at: University of Granada, Department of Optics, Edificio Mecenas, Av. Fuentenueva s/n, Granada, 18071, Spain.
E-mail address: ortizh@ugr.es (C. Ortiz).

https://doi.org/10.1016/j.aap.2018.04.018
Received 16 October 2017; Received in revised form 11 April 2018; Accepted 14 April 2018

General de Tráfico, 2016).

The majority of studies that have investigated the mobile-phone use on driving performance have focused on young drivers, because they are the first group in distracted driving fatalities. Results in several studies indicated that young drivers (from 18 to 21 yrs.), when text messaging, spent up to 400% more time not looking at the road than when not texting, with variability in lane position rising to 50% (Hosking et al., 2009). Also, the probability of being involved in an accident increased between 1.7- and 2-fold, compared to free driving (Yannis et al., 2016), with the 86% of the collisions occurred at the time of the dual task (Drews et al., 2009).

Distracted driving is also affected by driver age. Although older drivers show less distracted incidences while driving, they are not exempt. Cognitive, visual, and motor declines imply additional risk in distracted driving behaviour. Romoser et al. (2013) indicated that older drivers (from 72 to 87 yrs.) look less than younger drivers (from 25 to 55 yrs.) towards other areas where hazards are most likely. Also, Rumschlag et al. (2015) reported that the percent of subjects exhibiting lane excursions while texting increased with driver age group. However, the highest age of this sample was 59 years, and therefore some of the older drivers who used instant messaging applications were not studied.

In another study, Pope et al. (2017) analysed data collected with the *"Distracted Driving Behaviour Questionnaire"*. Their results showed that distracted driving happens in drivers of all ages. According to Deshmukh (2015), the WhatsApp user's age distribution is: 18% between 18–25 years, 29% between 26–35 years, 24% between 36–45 years, 11% between 46–55 years, 13% between 56–65 years and 5% over 65 years. Hence, today, a significant proportion of people over 55 are regular users of instant messaging applications and this proportion will augment given that older adults are increasingly accepting new technologies (Mitzner et al., 2010) and that drivers who are now more frequent users will be older in a few years.

Texting and driving are both mainly visual tasks. One of the most important causes of the vulnerability in older drivers is vision as it is one of the most critical sensory mechanisms in the driving task. Aging causes a series of physiological changes in ocular structures that imply a worsening in visual performance and optical quality (Artal et al., 1993; Martínez-Roda et al., 2016; Owsley et al., 1983). This worsening can be significant in later adulthood even when the visual acuity is much greater than the minimum limit required by driving regulations (Ortiz et al., 2013). Older drivers often mention night-time driving difficulties with oncoming headlight glare being a particular problem, likely due to increased intraocular scatter from age-related changes in the lens and ocular media. The most common visual test for driver licensing is the measurement of high-contrast visual acuity, but this visual function has not shown strong correlations with driving ability (Owsley and McGwin, 2010), making it necessary to evaluate the visual function with other nonstandard vision tests. Szlyk et al. (1995) found a significantly poorer driving performance in older drivers (from 50 to 83 yrs.) with and without visual impairment compared to young drivers (from 19 to 49 yrs.) when assessed with a driving simulator. One visual function that has shown a significant association with driving is contrast sensitivity (Fraser et al., 2013; Freeman et al., 2006; Owsley et al., 2001) but in most cases this visual function is not tested before the driver license is issued. In fact, when contrast sensitivity becomes severely impaired due to cataracts in older drivers, crash risk increases even when it affects only one eye (Owsley et al., 2001). However, contrast sensitivity not only decreases with ocular pathologies, but it also undergoes an age-related decline (Owsley et al., 1983). As a result, older drivers have less visual-discrimination capacity in such a way that signals, pedestrians or traffic lights could go undetected. Older drivers also have a narrower useful field of view (UFV). Thus, the study conducted by Bromberg et al. (2012) has shown that, despite reducing the driving speed, elderly drivers (> 65 yrs.) may still encounter problems in detecting pedestrians that appear outside the centre of their UFV. These visual changes also affect the secondary task in distracted driving, requiring greater driver attention and, therefore, making this dual task riskier. Chaparro et al. (2005) concluded that older drivers (mean age = 69.2 yrs.) identified significantly fewer road signs and drove more slowly than did the younger participants (mean age = 27.3 yrs.), and this was exacerbated for the visual dual-task condition. Other studies have reported similar results (Shinar et al., 2005). In recent years, interest in vision in relation to driving has intensified because we have no enough evidence concerning the visual functions that are most involved in driving performance.

For everything indicated above, we hypothesize that instant messaging use, which is becoming steadily more common among drivers of all ages, has a negative effect on driving performance and this effect could be worse in older drivers due to the age-related visual impairment.

Thus, the purpose of the present study was to compare the effect of new forms of communication (e.g. texting WhatsApp messages) on driving performance through different age groups, covering all ages of instant messaging applications users, and correlate it with different visual parameters. This is especially important because other nonstandard vision tests could be needed to guarantee adequate visual requirements to get a driving license and thus to promote driving safety as much as possible. A secondary aim was to compare the results from a driver simulator (objective data) with self-report data from distracted-behaviour surveys in all age groups (subjective information).

2. Material and methods

2.1. Participants

A total of 75 drivers (53 male and 22 female subjects) participated in this study. All were in good general health without any ocular disease and having best-corrected visual acuity equal to or better than 20/25 in both eyes. They were active drivers with a valid driving license for at least one year, who reported that they drove regularly (at least 1000 km in the last year), and had prior experience using a mobile phone while driving. All participants used WhatsApp as a common form of communication and they can be considered experienced in sending WhatsApp messages (≥10 WhatsApp messages/week). Subjects were divided in four age categories: 20 young adults 18–24 years old (22.4 ± 1.4 years), 20 adults 25–39 years old (30.2 ± 4.2 years), 20 middle-aged adults 40–54 years old (46.6 ± 3.6 years), and 15 older adults more than 55 years old (61.3 ± 4.1 years).

Finally, prior to participating in the study, all the drivers signed a written informed consent in accordance with the Helsinki Declaration (World Medical Association Declaration of Helsinki, 2001).

2.2. Visual and optical performance

2.2.1. Contrast-sensitivity function

The contrast-sensitivity function (CSF) reflects the sensitivity of the visual system, not only regarding size but also contrast. The experimental procedure for determining the CSF consists of measuring the contrast threshold (i.e. the contrast required to see a visual target reliably on a uniform background). The inverse of the contrast threshold as a function of spatial frequency is the contrast-sensitivity function. The CSF was measured, for all participants monocularly and binocularly with their best correction, with the CSV-1000 test (VectorVision, Ohio, USA) at 2.5 m (Fig. 1a.). This test has been demonstrated to be a reliable tool for measuring contrast sensitivity (Pomerance and Evans, 1994). The chart presents four rows, each corresponding to one of four spatial frequencies: 3, 6, 12, and 18 cycles/degree (cpd). Each row presents 17 circular patches. The first patch in the row presents a very high contrast grating in the far left of the row. The remaining 16 patches appear in eight columns presented across the row. Each column presents a grating patch, and the other patch is blank. The patches that