Revue européenne de psychologie appliquée xxx (2015) xxx–xxx

ELSEVIER MASSON

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Original article

Factors influencing drivers' reading and comprehension of on-board traffic messages

Facteurs influençant la lecture des automobilistes et leur compréhension de messages embarqués portant sur le trafic routier

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ARTICLE INFO

Article history:
Received 10 September 2013
Received in revised form
15 September 2015
Accepted 16 September 2015

Keywords:
On-board traffic information system
Reading and comprehension
Pictograms
Warnings
Recommendations

ABSTRACT

Introduction. – When variable message signs (VMS) or on-board traffic information systems are used, it is essential that while driving, motorists read and understand the information as soon as possible in order to make appropriate decisions to increase road safety and/or facilitate traffic flow. Thus, it is important to investigate the factors that may increase fast reading and comprehension of on-board traffic information.
Objectives. – We examined the influence of the type of message (warnings vs. recommendations), location of the pictogram (top or bottom of the text), type of display device (IPhone, Blackberry, or Tablet) and its position (horizontal or vertical) on drivers' fast reading and comprehension of on-board messages provided via in-vehicle system. Moreover, we were interested in drivers' acceptability of in-vehicle system.
Method. – Forty-nine drivers (M_{Men} = 32, 19–65 years) participated to a reading and comprehension task while travelling on a desktop driving simulator. Participants were exposed to two series of 11 traffic messages displayed on one of the three devices. Reading and comprehension times were measured (= milliseconds) for each message. At the end, they had to fill in a questionnaire on their beliefs about on-board traffic messages and in-vehicle system.
Results. – Drivers expressed a positive attitude toward on-board traffic messages and in-vehicle system. Reading and comprehension times were of approximately 4 seconds and were longer for warnings as compared to recommendations. The pictogram placed at the top of the text, the tablet and the vertical display device facilitated fast reading and comprehension.

Mots clés :
Système d'information embarqué portant sur le trafic
Lecture et compréhension
Pictogrammes
Messages d'alerte et messages de recommandation

RÉSUMÉ

Introduction. – Lorsque l'on utilise des panneaux à messages variables (PMV) ainsi que des systèmes d'information embarqués portant sur le trafic, il est essentiel que les automobilistes au volant puissent lire et comprendre dès que possible l'information qui leur est transmise afin qu'ils puissent prendre des décisions appropriées pour augmenter la sécurité et/ou faciliter la fluidité de la circulation. Ainsi, il est important d'étudier les facteurs qui pourraient augmenter la lecture et la compréhension rapides des informations de trafic.
Objectifs. – L'objectif de cette étude pilote a été d'examiner l'influence du type de message (alerte ou recommandation), la position des pictogrammes (en haut ou en bas du texte), le type de support de présentation (iPhone, Blackberry ou tablette) et son orientation (verticale ou horizontale) sur la lecture et la compréhension des messages diffusés à l'aide du système Co-Drive. De plus, on s'est intéressé à l'acceptabilité par les automobilistes de ce système.

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http://dx.doi.org/10.1016/j.erap.2015.09.002

Méthode. – Quarante-neuf automobilistes (hommes = 32, 19–65 ans) ont participé à une tâche de lecture et de compréhension de messages alors qu'ils conduisaient sur un mini-simulateur de conduite. Deux séries de onze messages leur ont été présentés sur un des trois supports. Les temps de lecture et de compréhension des messages ont été enregistrés en millisecondes. À la fin de l'expérience, ils ont été invités à remplir un questionnaire sur leurs opinions envers les messages et le système Co-Drive.

Résultats. – Les automobilistes ont manifesté une attitude générale plutôt positive envers les messages et le système Co-Drive. Les temps moyens de lecture et de compréhension de messages étaient d'environ 4 secondes. Les temps de lecture et de compréhension de messages d'alerte étaient plus longs que pour les messages de recommandation. Les pictogrammes placés en haut des messages, la tablette et la position verticale du support sont des facteurs qui favorisent la lecture et la compréhension des messages.

1. Introduction

Advanced on-board traffic information systems have become a major focus in emerging vehicle designs. These systems provide accurate real-time traffic information, which ameliorates drivers' capacity to anticipate traffic events and manage interactions with the road environment; facilitates road safety and circulation flow and, in consequence, encourages sustainable mobility (Jamson, Merat, Carsten, & Lai, 2013).

Despite the obvious advantages, numerous researchers have pointed out the negative distracting effects of in-car technology on driving performance by using both visual and auditory in-vehicle secondary tasks. Thus, Dewing, Johnson, and Stackhouse (1995) have examined the impact of three secondary tasks (i.e., undertaking simulated mobile phone conversation, finding objects from a closed container, and interacting with an in-vehicle traffic information system). Consistent with Liu's findings (2001), results have shown that interaction with the visual rather than the auditory task reduced drivers' primary task performance.

Further studies have manipulated the complexity of both primary and secondary. Verwey (2001) has shown that increased complexity of interaction with an in-vehicle information system lead to an augmentation of the number of unsafe driving situations. Radeborg, Briem, and Heman (1999) have examined performance on auditory recall and judgement task by varying the complexity of the primary task and have found that increasing the difficulty of the primary task had no significant effect on secondary task performance.

While driving, motorists are often required to make fast decisions – sometimes within a period corresponding to milliseconds – in order to avoid hazards or risky situations. As a consequence, any information provided via on-board traffic information systems (e.g., Bierlaire, Thémans, & Axhausen, 2006; Caird, Chisholm, & Lockhart, 2008; Caird et al., 2006; Regan, 2004), variable message signs (VMS) or road safety campaigns (e.g., Delhomme, Dedobbeleer, Forward, & Simoes, 2009; Fylan & Stradling, 2014; Haddad & Delhomme, 2006) demands fast reading and comprehension for allowing the driver to take fast adequate decisions.

So far, numerous empirical studies have examined drivers' behavioural reactions and comprehension of messages provided via VMS (e.g., Arditi, 2011; Dudek, Schrock, Ullman, & Chrysler, 2006; Dutta, Fisher, & Noyce, 2004; Ullman, Ullman, Dudek, Nelson, & Pesti, 2005) and road safety campaigns (e.g., Delhomme, Chappé, Grenier, Pinto, & Martha, 2010).

In this vein, Rämä and Kulmala (2000) have studied the influence of the "slippery road" message provided via VMS on motorists' speed behaviour using a driving simulator. Thus, a reduction of approximately 2 km/h in the average speed on slippery road was observed among motorists who were exposed to the message compared to those who had not been exposed. Furthermore, Luoma, Rämä, Penttinen, and Anttila (2000) have obtained similar results among 225 drivers, half of which were exposed to the "slippery road" message displayed on VMS. Moreover, the presence of the message has been reported to reduce drivers' attention to seek cues of potential danger and determine them to drive more careful on the slippery segments of the road. Erke, Sagberg, and Hagman (2007) have investigated the effects of presence vs. absence of a message informing about a closed road segment and recommending an alternative route displayed on two VMS on drivers' route choice and speed behaviour. Results have shown larger speed reductions and higher compliance with choosing alternative routes among drivers who had seen the messages compared to those who had not seen them.

Although there are several factors (e.g., distance from VMS, weather conditions, visibility, exposure time) that might differentiate between VMS and on-board messages in terms of comprehension and effects on driving performance, these results underline the importance of in-vehicle information comprehension and raise the question of the factors that may facilitate traffic information fast reading and comprehension allowing drivers to take quick appropriate decisions and avoid risky situations.

Empirical research has shown that reading and comprehension might depend on different factors that will be discussed below in details. The *length of the message* (e.g., Arditi, 2011; Ullman et al., 2005), *colour use* (e.g., Shaver & Braun, 2000), *presence of pictograms* (images, symbols) (e.g., Shinar & Vogelzang, 2013; Tijus, Barcenilla, de Lavalette, Lambinet, & Lacaste, 2007), *type of display device* (Delhomme, Cristea, Imbert, & Mondet, 2013), *type of message* (Wang, Keceli, & Maier-Speredelozzi, 2009) as well as *drivers' characteristics* (Al-Madani & Al-Janahi, 2002) were identified as possible factors.

1.1. Length of the message

Numerous studies have shown the negative effects of in-car devices for texting, cell phone conversations or interacting with music players while driving (Briem & Hedman, 1995; Brookhuis, De Vries, & De Waard, 1991; Goodman et al., 1999; Haigney & Westerman, 2001; Horrey & Wickens, 2006; Jamson & Merat, 2005). However, while piloting a vehicle, the main aspects of driving are "automated" and easily back grounded when additional tasks such as looking for directions on the GPS display or reading an on-board traffic message are introduced (Levy & Pashler, 2008). Furthermore, Dudek and Huchingson (1986) have shown that motorists are capable of processing one word (= 1 unit of information) presented on VMS per second without feeling distracted from their primary driving task. Richards, McDonald, Fisher, and Bracksone (2005) have found that, while travelling at 112 km/h, 4 to 6 seconds is the maximum safe viewing time of a VMS message for a driver to accurately comprehend the information without any interference on their driving activity. Ullman et al. (2005) investigated the effects of 4-units (= four words) vs. 5-units of information on 32 drivers'