VIAS institute

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An eye movement study on the influence of the position of navigation systems while driving – Summary

Federal Public Service
Mobility and Transport

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Summary

Introduction

The use of digital navigation systems such as portable (or standalone) devices for navigation, built-in (or fixed) navigation, and smartphone and tablet apps for navigation has become an integral part of driving a car. Research has shown that these systems generally have a positive effect on driving performance. However, they remain a source of distraction, since their use requires dividing attention between the device and the road, which can compromise safety. Most research about the safe use of digital navigation devices focuses on the design of the device itself and/or the interaction between user and system.

This report focuses on a third factor known to influence safety, namely the position of the system in the car. The position of the navigation device has been shown to influence both driving performance and the driver's attention distribution between the navigation system and the road. Placement of the system outside the field of view increases reaction times, reduces vehicle control and diminishes the ease of use.

An optimal position cannot be deduced from the existing literature. According to the guidelines used by car and navigation unit manufacturers the system should be easily visible without obstructing the view of the road. Belgian traffic law does not specify rules regarding the use or placement of navigation devices.

The aim of the current study was twofold: On the one hand, we wanted to find out how digital navigation systems are used by the Belgian population. On the other hand, we wanted to examine the impact of the most frequently used positions for navigation devices by Belgian drivers on safety and visual attention distribution.

Survey study

A representative sample of 1182 Belgian car drivers who were in possession of a driving license for at least two years and who drove at least 1500 km per year, completed an online survey. The respondents were asked what kind of navigation systems they possess, which types they actually use and in which position, and what their attitude is towards the systems.

The results show that 87% of the drivers are in possession of one or more digital navigation systems. Half (50%) of them have a built-in system. Also about half (47%) of them have a portable system and about a third (34%) indicate having a navigation app on the smartphone.

In practice, mostly built-in systems are used (43%). Portable systems (32%) and apps (24%) are used less often. In addition, many drivers use road signs that indicate direction (57%) for navigation, while paper maps and route descriptions are almost no longer used (10%).

Portable devices are often or always used with an attachment system by 80% of the users. This is only in 46% the case for smartphone users. The windshield or front window (74%) is the most popular position to mount portable devices, with 60% of the respondents indicating the mid-bottom area of the window. When mounted, the smartphone is mainly fixed to an air vent (45%) or the front window (27%). When not mounted, the device is mainly placed between the gear lever and the front of the car, or laid on the passenger seat.

Furthermore, most users of digital navigation systems rely on both visual and auditory information (79%), the majority of users finds their navigation system reliable (89%) and clear (69%) and only 7% thinks a navigation system/app is unsafe in the car.

Eye-tracking study

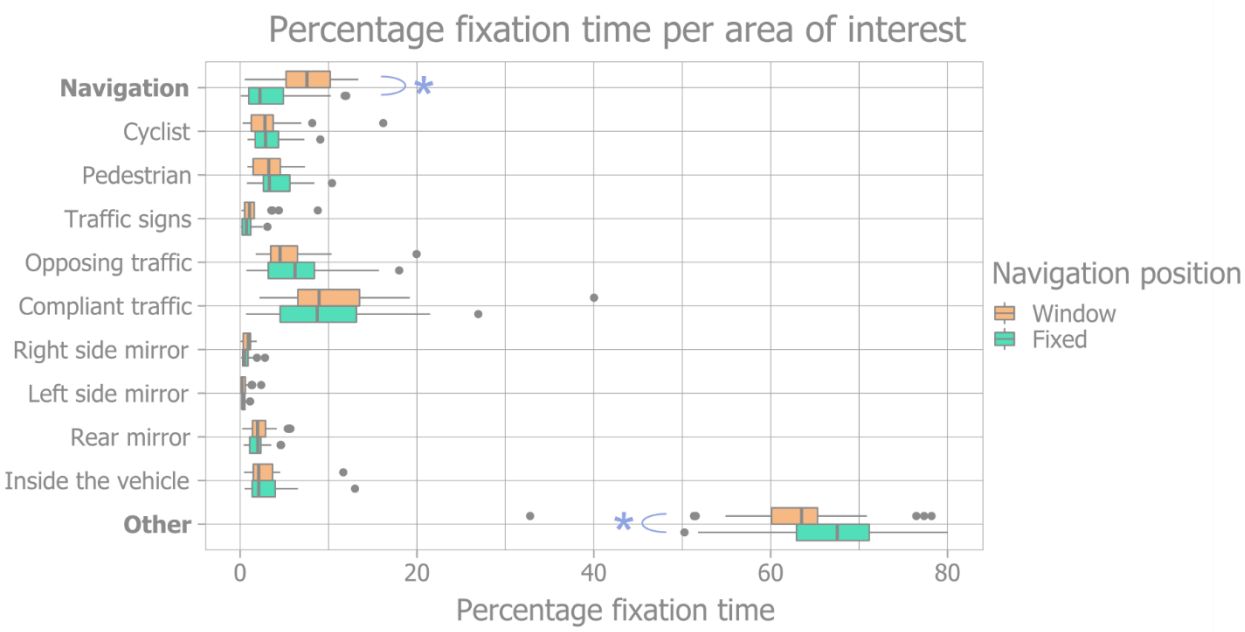
The second part of the study aimed at identifying differences in visual attention distribution and ease of use between the two most frequently used mounting positions for navigation systems in Belgium. These two positions were derived from the aforementioned survey study. The first position was the centre console of the car, where built-in devices and smartphones are often attached (henceforth called 'fixed'). The second position was the mid-bottom area of the front window (henceforth called 'window'), where portable devices and smartphones are often attached (see Figure A).

Figure A Image of the positions 'WINDOW' and 'FIXED' that were used in the eye-tracking study.

A sample of 27 subjects each drove two rides on the public road during which the position of the navigation system was manipulated. Each participant had at least two years a driving license, drove at least 1500 km per year and had experience with digital navigation systems. During one ride the device was attached to the windshield, and in the other ride it was attached in the position typically used for fixed devices. The order of the rides and the position of the navigation system were counterbalanced among the participants. Throughout the ride, eye-tracking registration allowed continuous monitoring of where the driver was looking. After each ride, subjects indicated how demanding they found the ride on six subscales of the NASA task load questionnaire. After the last ride they completed a questionnaire about their own possession and use of navigation systems, how they attach them, which information they use and what their attitudes are with respect to digital navigation systems.

When the navigation system was attached to the window, the subjects spent about twice as much viewing time (7,4%) on the device than when it was in the fixed position (3,5%) (See Figure B).

Figure B Percentage of the total registered fixation time on each selected area of interest, for rides with the navigation device in the fixed and window position separately (Boxplots: Centre line: median, Box: 1st till 3rd quartile, Lines: spread, Dots: outliers). Statistically significant differences (p≤.05) according to joint test method are indicated with '*'.



The number of eye movements to the navigation system followed the same significant pattern: there were only half as many fixations on the navigation system in the fixed position (3,5%) compared to the window position (7,3%). Besides that, individual fixations on the navigation device attached to the front window lasted on average slightly longer (242 ms) than when it was attached in the fixed position (225 ms).

Besides the higher number of fixations and the longer total fixation time to the navigation in the window position, 78% of the subjects also indicated that they found this set-up easier to navigate than the fixed

position. When the device was in the fixed position, slightly more subjects felt frustration than when the device was attached to the window.

From the results it cannot be deduced that the navigation system in the window position causes more visual distraction. Although the subjects looked longer and more often at the navigation on the window, the individual fixations were also longer, suggesting that the fixations were conscious, and not the result of involuntary visual distraction. Moreover, subjects experienced less frustration when the device was positioned on the window and navigating in the window position condition was experienced as easier by the vast majority of the subjects.

In the fixed position, the total fixation time to the navigation was shorter and the fixations were less numerous and slightly shorter. This suggests a compensatory mechanism in the visual behaviour of the subjects to overcome the bigger distance of the navigation device to the central view on the road.

The observed differences in eye-tracking patterns, experiences and preference support thus the hypothesis that a smaller distance of the device relative to the centre of the visual field while driving facilitates the shift and division of attention between the road and the navigation device.

However, the differences in fixation pattern between both positions should be interpreted with caution, as inaccuracy in the eye-tracking registration may play a role. The actual differences between the two positions could therefore be larger or smaller than observed.

Conclusions and opportunities for further research

The online survey shows that digital navigation devices are now commonplace, nevertheless, they are not always used with a mounting system. This is especially the case for smartphones. Strikingly, smartphones are often placed at a location outside the norm-compliant zones. Specially designed holders for portable systems and smartphones are attached in many different places in the car, but the mid-bottom of the front window is the most popular position.

The two most frequently used positions for digital navigation systems are both located within the areas recommended by manufacturers: at the bottom centre of the front window and at the top of the central car console. The results of the eye-tracking study contain no evidence that a navigation position within the visual field during driving, such as the front window, would be disruptive or distracting. The results also do not indicate that placing the navigation device just outside the central visual field while driving, like on the top of the central car console, leads to less looking behaviour towards the selected traffic relevant areas. The slightly increased distance between the navigation device and the view on the road, seems to be compensated by adapted looking behaviour to the navigation (less and shorter fixations, shorter total fixating time). Thus, it cannot be inferred from the data that one of the two positions would be (un)safer than the other. In terms of ease of use, the position on the front window seems to be preferred.

Further research is needed to examine the impact of non-norm-compliant, yet frequently used positions, with or without a holder. The eye-tracking data are ideally supplemented with driving parameters through an instrumented car to allow a more complete interpretation in terms of safety. The interaction between driving experience, age and the position of the navigation system, as well as interactions between navigation position and complexity of traffic situations, are valuable research tracks. Furthermore, the rapid rise of new navigation methods such as head-up displays creates a growing need for knowledge about the impact of these systems on safety and division of visual attention. Finally, it should be analysed whether, to what extent and how the use of navigation devices does or does not contribute to the incidence of accidents.

Recommendations

Based on findings from literature and the results of this study, Vias institute proposes a number of recommendations.

With regard to regulations, norms and guidelines for the placement of non-built-in devices in vehicles would be useful. It would be good for users to keep the distance between the navigation device and the central view of the road as small as possible, taking care that the device does not block essential parts of the view of the road or the instruments on the dashboard. The use of such navigation devices should only be allowed when attached in positions that comply with these norms.

With regard to sensitisation, the importance of using a mounting system for all non-built-in navigation devices can be emphasized. This is especially relevant for navigation via a smartphone app, as many Belgian drivers lay their smartphone loose in the car. Based on the literature a larger distance between the navigation device

and the view of the road has been shown to negatively impact road safety. Instructions regarding the optimal position of that mounting system are also useful.

Furthermore, it can be generally recommended to sensitize drivers about the importance of road map updates as roads and infrastructure are constantly changing. This is important because a lot of navigation devices (built-in as well as non-built-in) and navigation-apps are not being updated automatically. With regard to infrastructure, it is generally recommended that the signposting is straightforward and clearly visible, and that changes to traffic situations and road infrastructure are communicated in time to providers of digital navigation information.

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