Drivers' self-estimation of attention

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Distraction has been shown to have a clear negative effect on driving performance, but despite that a majority of people regularly do things such as using their smartphone while driving people do not seem to constantly drive into trees. This suggests that people have an ability to regulate their behaviour to mitigate those risks.This study then looks at how people divide their visual attention while driving and if a new laboratory method is a valid way to replace or supplement some naturalistic attention-related research. Two types of data collection were used, a survey-data collection where the participants were shown video clips of different traffic situation and were asked to estimate what they looked at, and how much time they devoted to each visual target. Additionally, videos with eye glances recorded in actual traffic were coded for comparison. The result was not significant, and the method in its current form is therefore not a suitable replacement for studies in a naturalistic setting.

Introduction

Potential distractions in our cars were mostly limited to other people, billboards on the side of the road or a car radio. But as technology advances the number of potential distractions have now increased manifold. Such things as touch screen dashboards or smartphones does not only make it possible to answer a phone call or text message, but also try to draw our attention with notifications for all sorts of other things.

Purpose

The aim of this study is twofold. One of the objectives is to further examine differences and similarities in the way people divide their spare attentional capacity while driving. What input is necessary for safe driving and what is possible to ignore?

In what circumstances does the driver feel secure enough to execute secondary tasks not directly related to driving (changing the radio channel, texting, etc)? Is it possible to find a recipe for safe driving?

The primary intention however, is to compare the results derived from this laboratory-based study with more naturalistic glance data from the Swedish National Road and Transport Research Institute (VTI). By examining whether the results produced by the two different methods is similar, it will be possible to assess whether the new method used in this study could complement or replace more expensive and time consuming studies in naturalistic settings.

Background

Much research has been done looking at distractions negative impact on driver performance. It has been found that using mobile devices and email systems as a secondary tasks while driving has a negative effect on performance, doubling the amount of missed traffic signals and increasing response times by up to 30%. (Strayer & Johnston, 2001; Lee, Caven, Haake & Brown, 2001)

Even though a survey by Trygg-Hansa (n.d.) found that 80% of Swedish drivers talk on

the phone while driving, despite of this dangerous behaviour Trafikanalys (2015) reported a significant discrepancy with only 2,179 cases of severe traffic accidents out of the six million Swedish drivers. (Transportstyrelsen, n.d.)

This seems to suggest that drivers are able to regulate their behaviour in order to avoid the most serious risks of performing secondary tasks while driving. The mechanics behind this shows that a visually distracting task while driving does not affect the structure of the drivers' situational awareness (Young, Salmon, & Cornelissen, 2012). They instead put more emphasis on tasks related to vehicle control rather than visual scanning. It also has been found that if drivers adjust their speed in order to compensate impairment in gathering of information (Senders, Kristofferson, Levison, Dietrich & Ward, 1967).

It has been found that it exist differences in visual attention between novice and experienced drivers (Underwood, Chapman, Bowden & Crundall, 2002). Experienced drivers showed a more extensive scanning on demanding sections than novices and novices had poorer mental models of what was likely to happen. With the help of recorded eye fixations, significant differences in how often and on what, novices and experienced drivers looked (Underwood, Chapman, Brocklehurst, Underwood & Crundall, 2003). Similarly it has been found that cyclists, when assigned with the task to interact with a mobile phone, performed the task mostly on the expense of irrelevant targets (Ahlstrom, Kircher, Thorslund & Adell, 2015). However, the amount of glances at the traffic remained the same, but shortened in time. Additionally it seemed that the cyclists prepared for the tasks by choosing suitable locations and situations for phone interaction.

When looking at simulator-studies it has been found that even in a low-fidelity simulator a phone dialing task had a detrimental effect on performance in the stimulator similar to that in real traffic, however not as great as in real traffic (Reed & Green, 1999). Even in high-fidelity simulators and a video game in laboratory setting showed the same tendencies (Terai et al, 2012)

Method

The data in this project was collected through two different methods. A survey-based experiment was used for collecting data to find a potential recipe for safe driving. To test the validity of this method, additional eye-tracking data was provided from VTI and analysed for comparison.

Survey data

Participants for this study were recruited by an invitation sent to students at Linköping University as well as suitable experiment volunteers in a database provided by VTI. The only requirement for participation was that the potential participant possessed a driving license. A total of 26 participants took part in this study, with 14 men and 12 women, between 19 and 61 years of age (M=29.15 years, SD=12.19). The participants had possessed a driving licence between 1 and 43 year (M=10.69 years, SD=12.11) and their driving experience ranged from 200 to 90,000 km (M=13,568.75 km, SD=21,628.69) in total. Their driving experience over the last year ranged from 0 to 4,000 km (M=825.77, SD=1192.93).

Video material provided by VTI was used for the experiment. It was cut to twelve different video clips between 10 and 50 seconds each, showing different manoeuvres while driving on different roads in and around Linköping, with the perspectives of both forward view and rearview mirror. There were twelve different scenarios,

differing in difficulty depending on the intensity of the surrounding traffic, weather conditions and how much actual manoeuvring of the vehicle that was demanded of the driver. The following scenarios were used for the experiment: driving in the right lane, driving in the left lane, lane change to the left, lane change to the right, passing of off-ramp, passing of on-ramp, parked car on the side of the road, entering off-ramp, entering traffic circle, joining motorway, overtaking traffic, truck entering road.

For the test the participants were given surveys in which they were asked to estimate how they would divided their visual attention in the situations shown in the clips, imagining that they were driving the vehicle. The task was to specify which visual targets they would have looked at, as well as to estimate in percentages how much of their attention they would have devoted to each of these targets. Predefined on the survey was the speedometer, rearview mirrors and a column named secondary task, which the participants would fill in if they thought the traffic situation allowed an additional, secondary task. The participants were asked to add further targets by themselves as needed.

In the beginning of each test occasion the participants were given a consent form and a brief demographic questionnaire, before receiving the instructions for the experiment. The participants were given the surveys and then shown the video clips. There were one survey for each clip, which was filled in while the corresponding clip was shown. In order to give the participants enough time to fill in the survey, each clip was put on loop until every participant had completed the task. The order in which the clips were shown differed between each test occasion to minimise fatigue, order effects

and other potential sources of error and in turn ensure higher reliability.

The filled in surveys were then analysed and the targets for each clip were generalised and merged, depending on situation and function of the given targets. For example, if participants gave both "yellow truck" and "red truck" as targets in a clip showing these objects in the traffic ahead, these targets would be categorised as "traffic in same direction". This category included traffic overtaking the driver, traffic overtaken by the driver and traffic ahead of the driver. The attentional percentage for this category would be the sum of the attention given to the targets. The categories chosen for analysis were the following: speedometer, rearview mirror, traffic in the same direction, the road, the blind spot, road signs, non-traffic related targets, on-ramp, off-ramp, secondary tasks.

If the participants would have had difficulties in reaching a total percentage of 100, the given numbers would have been recalculated to the corresponding quota for a total sum of 100%. The average percentage of the categories were calculated for each clip as well as a general average for all clips. For each clip the average percentage of the attention spent on secondary tasks was calculated and tested with a Pearson product-moment correlation coefficient test.

Glance data

To examine the validity of the method described in the previous section, glance data collected from actual traffic were used for comparison. For this part of the study additional video material provided by VTI was used. The videos were similar to the ones used in the previous part except without the rear-view footage, showing only the driver's perspective of the road ahead. In these clips the gazes of the drivers had been tracked, visualised on screen by a blue mark

recording the eye-movements. A total of three one-hour-long videos were used for this part of the study. Each video had a different driver, all of which were male traffic instructors, between 31 and 46 years of age (M=40, SD=6.38). The routes were the same as in the previous part.

22 sequences between 10 and 30 seconds in length were selected from the glance videos. These were chosen to correspond most of the scenarios shown in the survey part with a few exceptions. Scenarios from the survey videos that were too situation specific were excluded from the glance data. The excluded scenarios were: entering roundabout, car parked on the side of the road, truck entering road. Between 2 and 5 corresponding sequences were chosen for each of the other scenarios. The sequences were analysed frame-by-frame, recording the distribution of the glances. The same generalised categories from the survey data were used with a few exceptions. The category "secondary tasks" was removed

eye-tracker had failed to register where the driver directed his eyes was also added. For each scenario the percental distribution for each category was calculated.

Joint analysis

After collecting and encoding all relevant data a joint analysis was required to examine the reliability of the survey-based experiment method. The categories from each clip in the survey-data was compared to the categories from the glance-data sequences. The average of percental attention for every category in each video clip was calculated and the difference then compared. No variables which were significant broke any assumptions regarding parametric data. Thus, parametric t-test was used to compare the means.

Results

Independent t-tests were conducted to compare the results from the survey and the glance data. There was a significant difference for the category "road" between
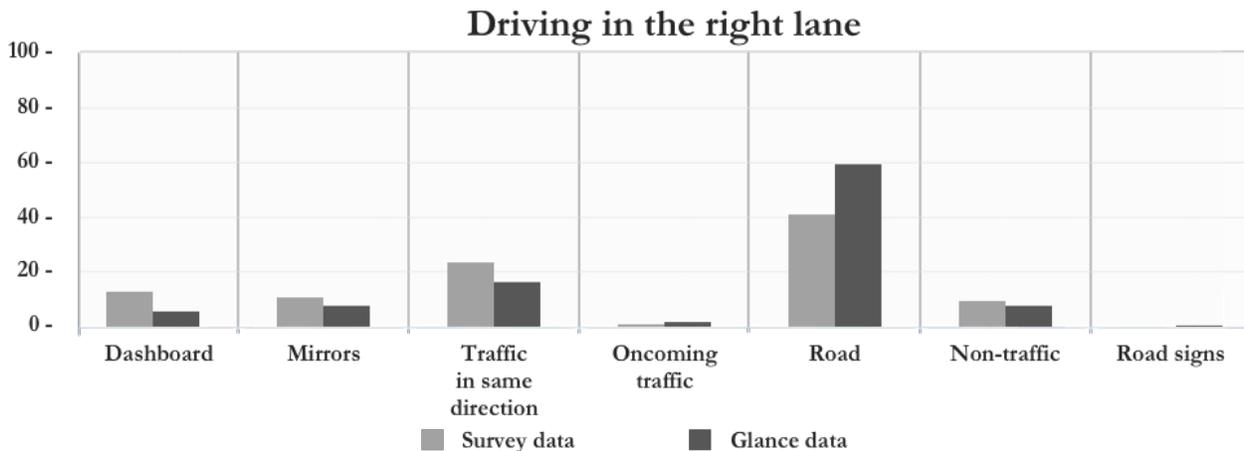

Figure 1. The results from one of the nine videos comparing survey data and glance data. This is one of the sequences with the least difference between the two.

because of the difficulties in determining whether the driver performed anything else besides driving. The blind spot category was also removed, since glances off the area shown in the videos were not recorded. An additional category for frames in which the

the survey data (M=.2278, SD=.10826) and the glance data (M=.4700, SD=.18628): t(16)=.004 , p=.004. There was also a significant difference between survey data (M=.2789, SD=.10764) and glance data M=.1000, SD=.05523) for the category "mirrors": t(16)=.

ooo , p>.ooo. This means that the participants did not estimate that their attention dividing was similar to that found in the glance data. For the rest of the categories the result was not significant.

A Pearson product-moment correlation coefficient test was performed to assess the relationship between the share of people willing to perform additional tasks and how much attention those willing to self-estimated that they had available. There was not a significant correlation between the two variables, $r=.6481$, $n=9$, $p=.059059$.

Discussion

The main purpose of the study was to assess whether a new laboratory method could replace or supplement studies in actual traffic in some attention-related traffic research. For the two categories "mirrors " and "road", which had had the highest percentage of all categories in most of the scenarios, there was a significant difference between the results from the survey and the glance data. Therefore the conclusion is that in its current form the method can not be used to replace or supplement studies in a naturalistic setting.

Many potential reasons exists for the difference between the two sets of data. One possibility is that it is simply very difficult to estimate how you divide your own attention. An example of this is that a lot of people overlooked some categories completely, such as for example the road itself which might be very easy to forget simply because it is always present, as well as the fact that the clips were relatively short makes it less likely that you would simply zone out. A further possibility is that it is not possible to obtain the situation awareness needed in the laboratory setting. While studies such as Terai et al (2012) have found similarities between driver behaviour between real traffic and very basic simulators, it might be

necessary to for example be able to look around. The analysis of the glance data itself could be a problem. The eye tracking is not always very precise and it was often necessary to use surrounding frames of the video to judge what the person was looking at. The video clips themselves were also not exact equivalences to those shown to the participants in the survey experiment, and though efforts were made to find as similar situations as possible it was not possible to find the exact same situation in the exact same location, and it is understandable that no one would look at traffic ahead when there is none.

Many potential improvements to the study exists. Pre-filled categories could considered to make it less likely that the participants in the survey might miss a category such as the road itself. The drivers used for eye tracking should come from the same demographic as the participants in the survey, meaning for example that any difference in driving experience between the two groups that causes differences in where they look, as found by Underwood et al (2002) should disappear. To overcome problems with situation awareness the laboratory could be made somewhat more like the real situation with more screens showing for example the side-windows of the car, making it easier for the participants to immerse themselves in the situation. The video shown to the participants and used for the glance data could be the same with the exception of the eye tracking dot being removed for the survey, meaning that the any difference caused by different situations should be eliminated.

As for the secondary objective to further examine differences and similarities in the way people divide their spare attentional capacity while driving, the possibility to do so is limited due to the fact that the method does not appear to be a valid way to study

the subject. However, one of the parts that might still be interesting to look at is how people were estimating their ability to spend time on secondary tasks. Due to the fact that there were no naturalistic data to compare it with, it is difficult to say whether it accurately reflects driver behaviour in the real world. But as drivers seems to be able to choose suitable spots to perform these secondary tasks (Ahlstrom et al, 2015), there might be some more conscious reasoning and planning behind this than for example visual search. If that is the case, perhaps their ability to estimate it might be better than for some of the more automatic mental processes.

If people can generally accurately decide in what situations that they can spend time on secondary tasks it should come naturally that on average more attention should be available to be spent on them in situations where more people are willing to spend time on them. However, in this study there was no significant correlation between the two. In order to be able to say whether it exists or not, a larger study would be needed.

<div align="center">References</div>

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