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Investigating driver distraction: the effects of video and static advertising

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Transport Research Laboratory

PUBLISHED PROJECT REPORT PPR409

Investigating driver distraction: The effects of video and static advertising

A Driving Simulator Study

by M Chattington, N Reed, D Basacik, A Flint, A Parkes (TRL)

Prepared for: Project Record:	**PO 3100173332** **INVESTIGATION OF GEOMETRIC DISTRACTION PARAMETERS OF ADVERTISING IN LONDON: SIMULATOR STUDY**
Client:	**Transport for London (TfL), London Road Safety Unit** **Kirsty Novis**

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The views expressed are those of the authors and not necessarily those of Transport for London (TfL).

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Project Manager	Andi Flint	26/05/2009
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Abstract

Roadside advertising is a common sight on urban roads. Previous research suggests the presence of advertising increases mental workload and changes the profile of eye fixations, drawing attention away from the driving task. This study was conducted using a driving simulator and integrated eye-tracking system to compare driving behaviour across a number of experimental advertising conditions. Forty eight participants took part in this trial, with three factors examined; Advert type, position of adverts and exposure duration to adverts. The results indicated that when passing advert positions, drivers:

- spent longer looking at video adverts;
- glanced at video adverts more frequently;
- tended to show greater variation in lateral lane position with video adverts;
- braked harder on approach to video adverts;
- drove more slowly past video adverts.

The findings indicate that video adverts caused significantly greater impairment to driving performance when compared to static adverts. Questionnaire results support the findings of the data recorded in the driving simulator, with participants being aware their driving was more impaired by the presence of video adverts. Through analysis of the experimental data, this study has provided the most detailed insight yet into the effects of roadside billboard advertising on driver behaviour.

Executive summary

Roadside advertising is a common sight on urban roads. The purpose of the advertising is to draw the attention of the maximum number of observers to the displayed product or service but this may represent a source of distraction and therefore collision risk for road users. Wallace (2003) reported the emergence of a consensus that roadside advertising contributes to over-complexity of the visual field and that this may result in excessive driver distraction. A driving simulator study was conceived to investigate the distraction of the driver from the driving task by static and video advertising. More recently research was conducted by Brunel University (Young & Mahfound, 2007) which demonstrated that roadside advertising has a detrimental effect on lane position control. The research also suggested the presence of advertising increased mental workload and eye fixations, drawing attention away from the driving task. The results of the study suggested the effect of advertising billboards may be more pronounced in scenarios which are monotonous or of lower workload rather than an urban environment.

Objectives

To provide guidance on the relative level of distraction caused by roadside billboard advertising with reference to advert:

- type (static vs. video adverts);
- position (placement relative to road);
- exposure time (duration over which advert is visible).

Assessment of driving impairment was made by analysing data recorded in a driving simulator. Visual distraction was assessed by analysing drivers' scanning behaviour using the output from an eye-tracking system.

Method

The study was conducted using TRL's driving simulator, CarSim, and its integrated eye tracking system. This has the benefit of allowing drivers to undertake potentially unsafe tasks in complete safety and that driving is conducted in controlled conditions enabling detailed analysis of both driving and visual behaviour.

It was requested that participants should represent a broad spectrum of the driving population to mimic that observed in London. This made the task of selecting suitable advertising content more challenging since it was important to ensure that the advertising used was approximately similar in its capacity to distract drivers. If this were not the case, effects caused by the experimental factors of interest could be diluted by particular adverts that were exceptionally distracting. This was addressed by using a novel and rigorous content validation process.

Content validation study

A range of static and video billboard type adverts were selected. These were presented to participants as paired comparisons using bespoke software and a two-alternative forced choice (2AFC) procedure was employed. This meant that participants were required to indicate which of the two adverts presented they thought most captured their attention. By repeatedly presenting the static and video advert pairs and scoring each advert based on the number of times it was selected, a homogeneous subset of adverts were selected for use in the driving simulator study. Thirty-four participants (16F; 18M) across a wide age range completed the study enabling selection of fourteen suitable static adverts and fourteen suitable video adverts, which were taken forward into the simulator study.

Simulator study

The study employed the TRL car simulator which recorded data relating to participants' operation of the vehicle and the position of the vehicle relative to infrastructure and other traffic. This was used to compare driving behaviour across experimental conditions. An integrated, non-intrusive eye tracking system was used to measure the frequency and duration with which participants looked at the advertising billboards.

Two simulated driving routes were created and 48 participants, mixed by age and gender, were recruited to drive each route in both directions. This gave four drives per participant. Participants were not told the true nature of the trials until they had driven all four drives. A bespoke visual database of a dense urban environment was used to provide a naturalistic setting for the advertising. Each route was approximately 13km in length, and at a steady speed of around 30mph, could be completed in approximately 15 minutes. The simulated routes were built to appear representative of the London hinterland and as such included features such as traffic light controlled junctions; tower blocks; bus stops; bus lanes; shop fronts; moderate traffic density with various vehicle types including cars, motorbikes, taxis, buses, and lorries. This created a relatively high degree of visual complexity and a suitably representative environment for the testing of roadside advertising (see Figure 1). Each route contained seven adverts plus some additional blank advertising boards.

Figure 1: Example screenshot of the simulated scenarios (including video billboard placed on a building to the left)

There were three factors for analysis in the trial. Advert *type; position*; and *exposure duration*. Four configurations of advert position were used on a building to the left; on a building to the right; on an overhead gantry; or three matching/synchronous adverts placed at all three positions.

The advert type factor consisted of two mechanisms of advert presentation – static and video advertising. Static advertisements displayed a simple combination of text and/or pictures that did not change. Video advertisements, in the simulated environment, repeatedly displayed short bursts (up to 6 seconds) of moving pictures equivalent to those that could be seen on a television.

Exposure time was controlled by the placement of infrastructure obscuring the adverts. Driving at 30mph, participants would be able to view at least 50% of the advert for two seconds (short exposure); four seconds (medium exposure); and six seconds or more (long exposure). To reduce factor combinations, exposure time was only varied for adverts positioned to the left of the road. All other adverts were at the intermediate exposure time.

All adverts were presented on a simulated '48 sheet' (6.10m × 3.05m) billboard advert. Investigation of driving and visual behaviour consisted of detailed analysis of performance in the 100m preceding each advert. A dataset of driving behaviour when no adverts were present was established by running the same analyses for the 100m preceding each advert from the drives when participants completed the driven routes in the opposing direction. This meant that the driving situation was similar (e.g. approaching a junction, negotiating a curve etc) but no adverts were visible and so comparisons could be made between this situation and that where adverts were present.

The objective data collected through the simulator and eye tracker were supplemented by participants' subjective opinions collected using questionnaires. A questionnaire was administered after each drive and a final questionnaire was administered at the end of the trials. These tested participants' recall of advertising (and also other elements of the route to ensure that the true purpose of the trial was not revealed), their mental workload during hazardous situations, how distracting they found video advertising, and whether they felt such advertising billboards would have an effect on safety.

Results

Significant differences were observed across the experimental factors. First, Figure 2 shows the mean number of glances participants made at advertising, this is broken down by each position the advertising appeared.

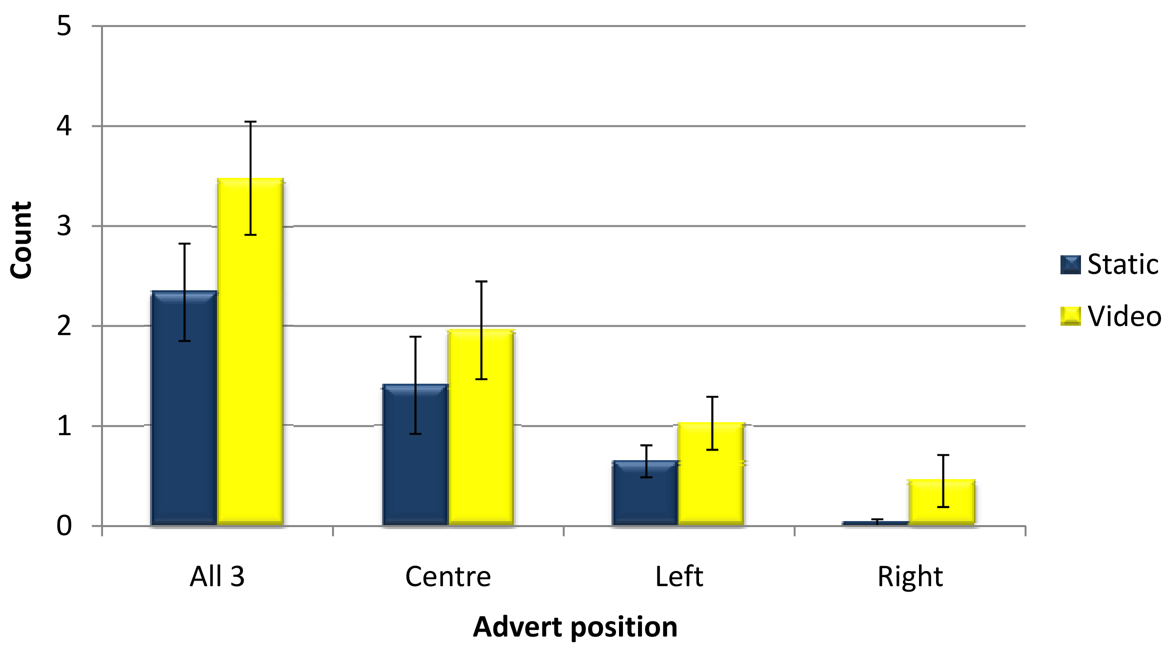

Figure 2: Mean number of glances at adverts across advert positions

There is a clear trend in the glance frequency from adverts at 'All 3' positions, which received the most glances, through to adverts to the right of the driven vehicle, which received fewest glances. Statistical comparison shows that there were significantly more glances made at video adverts for each positions type.

Figure 3 shows the variation in lateral lane position of the driven vehicle across the factors of advert position and presentation type.

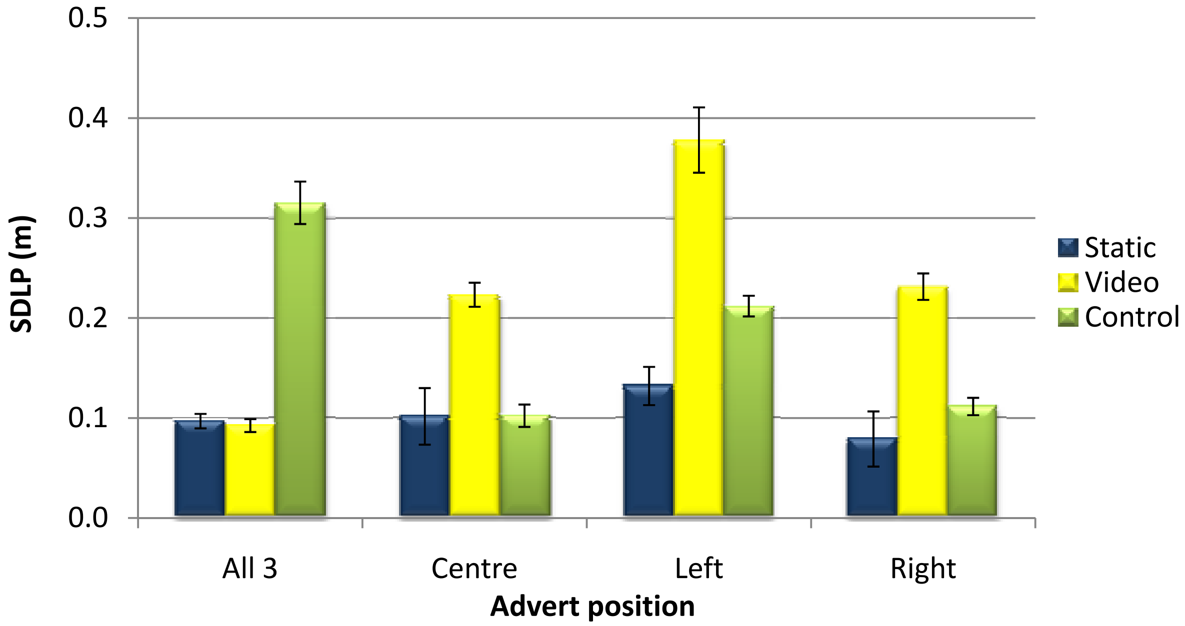

Figure 3: Standard deviation of lateral position across advert positions

At the centre, left and right positions there was significantly greater variation in lane position when video adverts were present than when static adverts were displayed.

Figure 4 shows the percentage of time that participants spent looking at adverts within the 100m analysis region approaching each advert across factors of presentation type and exposure duration.

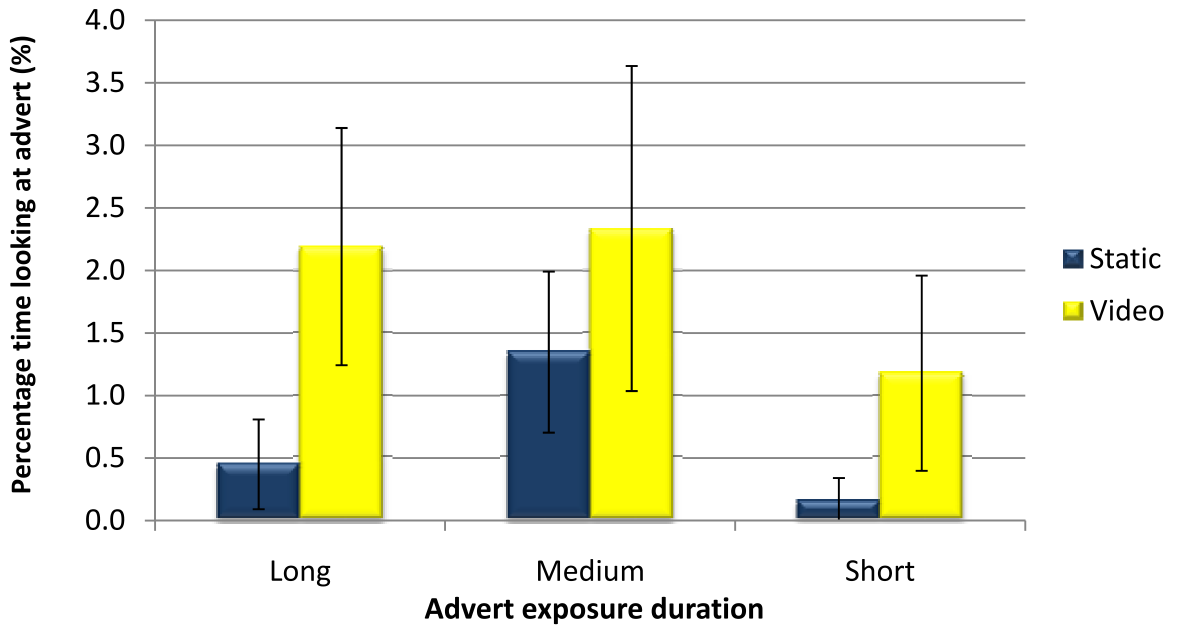

Figure 4: Percentage of time spent fixated on adverts across exposure duration and advert type

It can be seen that at each exposure duration participants spent a greater proportion of their time when viewing video adverts than when viewing static and comparisons at each exposure time reach statistical significance.

Next, Figure 5 shows how drivers' lateral position varied across the factors of exposure time and advert type.

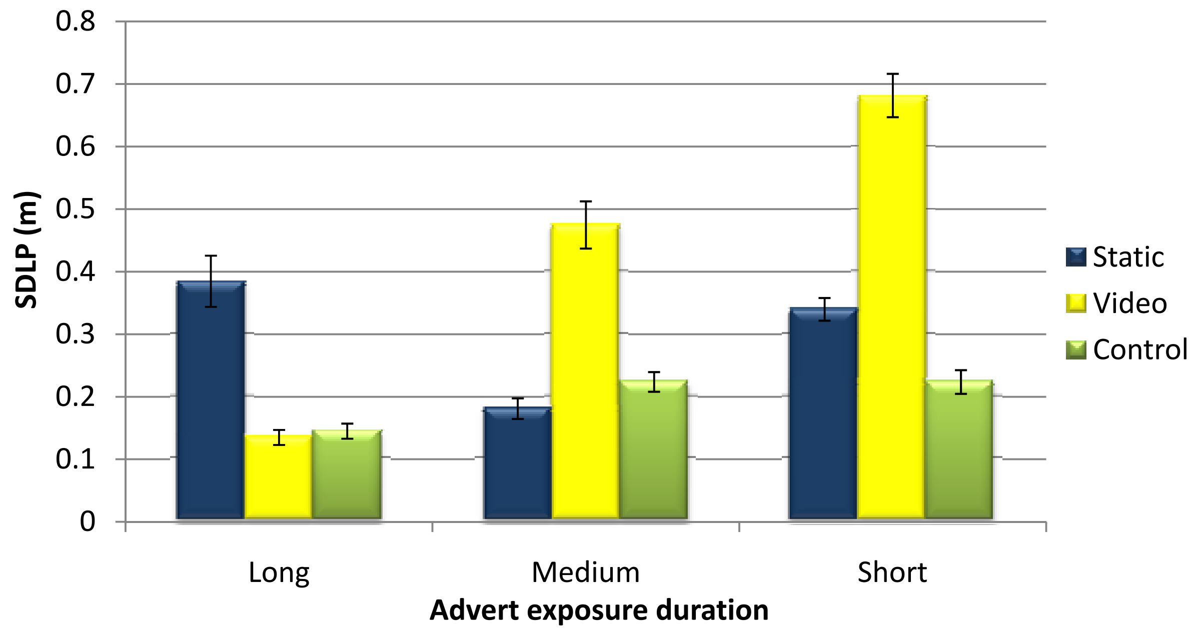

Figure 5: Standard deviation of lateral lane position across exposure duration and advert type

Again, there were significant differences between static and video advertising at each of the exposure durations. Drivers show more variation in lateral position with static adverts at long presentation durations but greater variation with video adverts at the medium and short durations. Further investigation shows that variation in lateral position is statistically consistent across the three exposure times for static adverts but increases significantly as exposure time decreases for video advertisements.

Whilst approaching each advert, brake usage was monitored and recorded. Figure 6 shows the maximum deceleration observed averaged across participants for each advert type across the exposure durations.

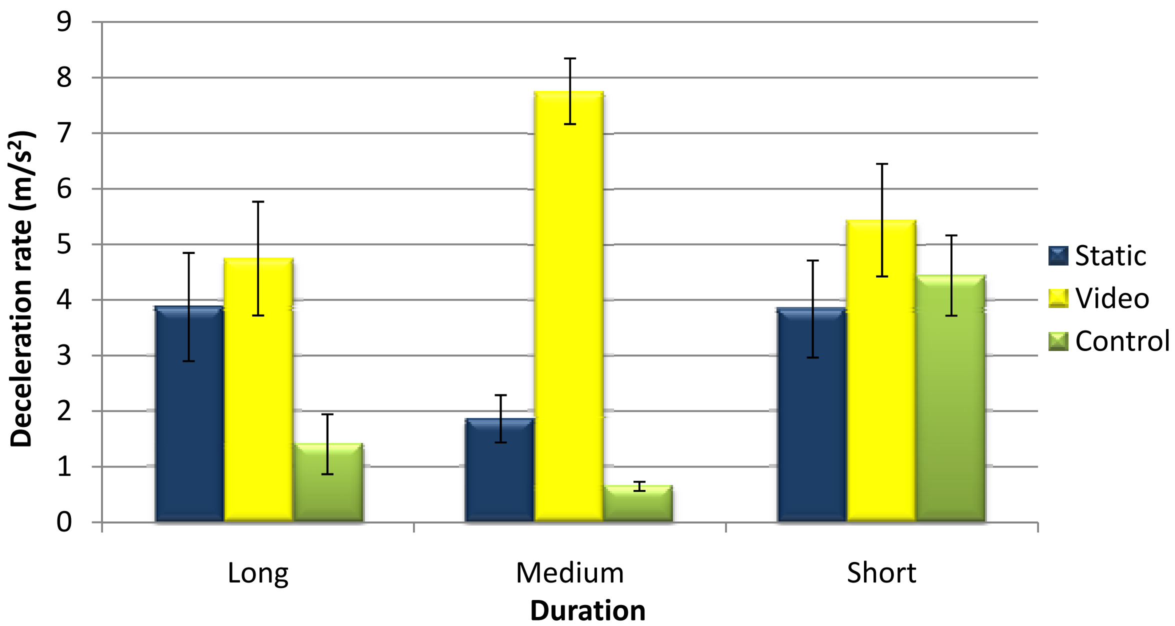

Figure 6: Maximum deceleration across exposure duration and presentation type

Statistical comparisons indicate that participants decelerated significantly harder with video adverts at both the short and medium exposure durations.

The speed of the driven vehicle in the 100m preceding each advert was recorded. Figure 7 shows participants' mean speed on approach to each advert.

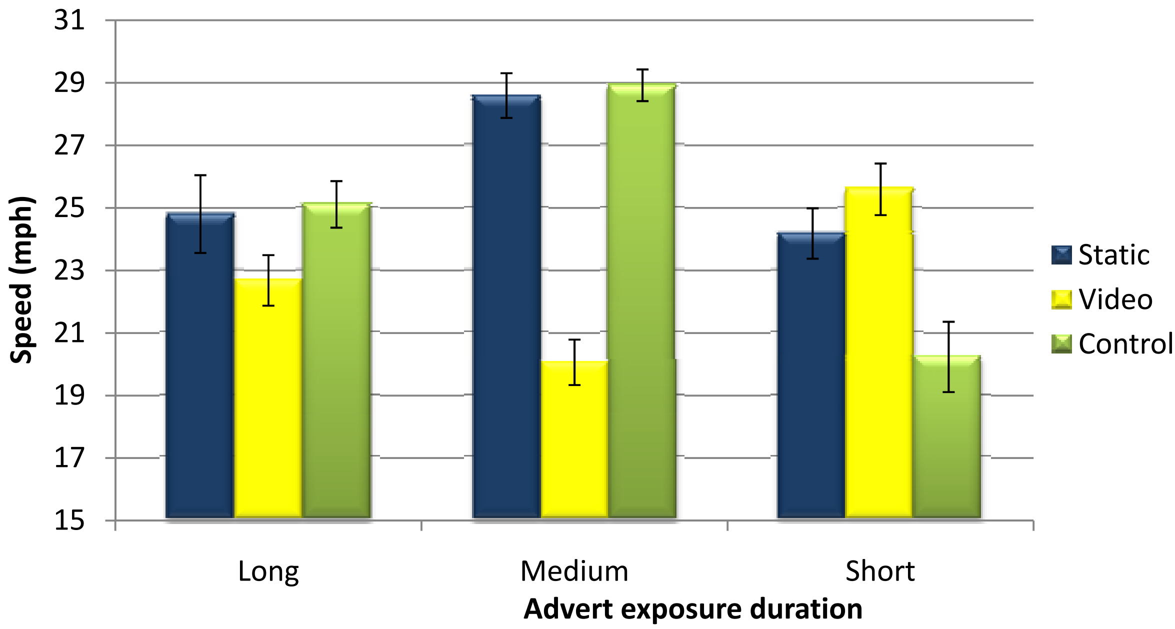

Figure 7: Mean speed of approach across exposure duration and presentation type

Comparison of speeds across advert type revealed that speeds were significantly higher in the long and medium exposure times for video adverts over static adverts. It can be seen that speed choice with static adverts appears more similar to control driving than to when video adverts are present.

Analysis of the questionnaire data in this trial indicated that drivers believe that:

- video adverts are more distracting than static adverts;
- video adverts are less safe than static adverts;
- there is no significant difference in distraction caused by adverts placed on the right or left of the road;
- adverts placed directly above the road is more distracting than advertising boards placed on either left or right of the road;
- adverts placed on the right, left and centre of the road ('All 3' configuration) is more distracting than any single board, placed on the left, right or centre of the road.

Many participants also commented in the questionnaire that they felt that video adverts were more hazardous. For examples:

"I found the full motion video advertising billboards very distracting and these were losing my concentration on the road. Static billboards are not very distracting as nothing is moving in them."

"Other than legal, legitimate road signs giving instructions to motorists, advertising billboards of any sort should be kept away from the sides and above roads. Especially video signs as they could mentally confuse the eyesight and cause accidents."

"Full motion video make you look at them and stop you from thinking about what is going on around you. Flashing images make you look at them - we think of flashing as a warning. Static boards you can look at like road signs and you normally recognise them without having to look longer at them, if you see them at all!"

"With static adverts you can possibly take in most of the image at a glance - whereas the motion adverts require a lot more attention to follow sequences etc., therefore taking attention from looking at road and pedestrians."

Discussion

This study set out to investigate the relative level of driver distraction caused by a range of billboard advertising configurations with a particular focus on the effect of video adverts as compared to static adverts.

An approximately homogeneous set of adverts was defined using a pre-trial content validation study that facilitated comparison of the different advertising configurations in the subsequent driving simulator study. The simulator study revealed numerous interesting differences in behaviour across the experimental factors. When compared to behaviour when passing static adverts, participants in the study:

- spent longer looking at video adverts;
- glanced at video adverts more frequently;
- tended to show greater variation in lateral lane position with video adverts;
- braked harder on approach to video adverts;
- and drove more slowly past video adverts.

This combination of results indicates that video adverts caused a significantly greater impairment to driving performance than that caused by static adverts. One perhaps counterintuitive result is that drivers went slower past the video adverts, which at first glance appears to indicate safer driving. However, visual behaviour analysis suggested that participants were slowing down to view the video adverts. This combined with greater variation in lane position (indicating poorer tracking ability) and harsher braking (indicating slower reaction times) suggests an overall impairment to driving ability when viewing video adverts. The increases observed, particularly at the short duration exposure time are consistent with a greatly increased tendency to drift into the offside lane or onto the nearside kerb, greatly increasing the risk of collision and/or injury. By comparison with other impairments tested on the simulator, cannabis has been shown to increase variation in lane position by 35% whilst trying to write and send a text message caused this measure to increase by 91%. Although, the measures reported here were taken in a different driving environment and context, it is apparent that the impairment to performance when viewing video adverts is of a similar magnitude.

Advertising position had predictable effects on participants' viewing of the adverts. When the adverts were placed in a position requiring less effort to view, participants were more likely to look at the advert. However, there was an interesting interaction in terms of variation in lane position in that it was video advertising placed on the left of the road ahead that caused the greatest variation in lateral lane position. This suggests that the position an advertisement is placed relative to the observer is significant in determining whether that advertisement can be considered safe.

The questionnaire results support the findings from the simulator in that participants tended to be aware that their driving was more impaired by the presence of video adverts than with static adverts.

Although this study does not provide an exact replica of the situation observed with real driving, there are significant methodological, safety and price constraints that make studies of real world behaviour in relation to distraction by billboard advertising very difficult. In using the driving simulator at TRL, every effort was taken to ensure that this simulator study represented the London driving scene as accurately as possible. In addition, a number of experimental factors could be manipulated in a manner that is not possible in the real world, large volumes of accurate data could be collected, and participants were in complete safety at all times. Through analysis of the experimental data, this study has provided useful insights into the differential effects of roadside billboard advertising on driver behaviour.

Further work

TRL has proposed further work to reanalyse the existing data to establish drivers' normal (driving and visual) behaviour when adverts are not present. This may help to understand the true level of impairment caused by the various advertising configurations.

Further possible studies may investigate:

- On-road/on-track validation of simulator results
- Simulator study involving greater density of static/video advertising
- Examining the effect of different sizes of static/video advertising
- Benchmarking the effect of different content types (high vs. low distraction)
- A review of collisions in London in relation to the presence of nearby advertising

1 Introduction

The optimal positioning for roadside advertising is a key issue in the marketing and advertising industry, given their ever growing interest in attracting driver's attention while on the road. There is a distinct lack of direct research into this area, however, there are number of research articles that have considered the effect of stimuli external to the car on the attention of a driver. The advent of affordable plasma and LED screens showing video advertising may result in these forms of advertising being more widely used as highway advertising hoardings. Advertising has already begun to move into a more digital form. For example, in May 2006, London Underground signed a £72m contract with Viacom Outdoor, with a view to installing digital escalators panels and digital cross-track projection.

The purpose of this study was to determine the distracting nature of advertising placed near roads of a similar type to those found in the London area. As part of this study we have also aimed to identify the "worst case" geometric orientation(s) of advertising hoardings i.e. which advertising positions create the greatest distraction for a driver. This report has aimed to provide objective and independent evidence that can be used to support or refute arguments to initial applications to display advertisements. To date, highway authorities have been unable to present evidence demonstrating the distracting nature of advertising hoardings.

While driving a car, it is estimated that attention can be distracted to irrelevant objects and features near the roadway between 20% and 50% of the time (Green, 2002; Hughes & Cole, 1986; Land & Lee, 1994). Concerns have been voiced by Wallace (2003) regarding driver's ability to cope with the volume of advertising and other distracting features that can be found around roads today. This research suggested that, as drivers, we have a limited capacity to process information (particularly visual) and it is possible that some drivers exceed this threshold due to the increased amount of advertising present around modern roads. There were 23,210 reported collisions in London in 2007 (TfL, 2007). Of these collisions, 261 have a contributing factor of 'distraction outside vehicle'.

Different types of advertising can also play a part in distracting a driver from their main task: maintaining safe control of the vehicle whilst responding to events in a reasonable time. Crundall *et al.*, (2006) investigated two separate groups of advertising; the first group was termed street-level advertisements (SLAs). These SLAs consisted of mainly bus shelter mounted hoardings and advertisements that were no more than 3 metres above road level. The second group was termed raised-level advertisements (RLAs), these consisted of all types of advertising that is more than 3 metres above the group i.e. large advertisement boards and bridge mounted hoardings. Although this study was based on drivers viewing a video of the drive and not directly travelling the route as a driver, it still has clear relevance to the current research. The authors monitored the participants' eye movements during the video playback and found that SLAs received the most fixations when the participants were asked to examine the route for hazards. Furthermore, Wallace (2003) notes that billboards are a major contributory factor to distraction incidents. Interestingly, when a driver was asked to look for advertising along the route, it was the RLAs that received significantly more fixations than the lower level advertising (Crundall *et al.*, 2006). The authors also performed a memory test following the trials, in an attempt to examine which mode of advertising was more successful in being retained by the drivers. It was found that although the street-level advertising was fixated more often and for longer periods than the raised level advertising, it was not recognised by the drivers in the memory test. One of the studies main conclusions suggested that street-level advertisements fail to be as effective as the raised advertising. SLAs also provide a strong distraction, supported by the greater fixation time on the advertisement, and this mean that they may be inappropriate to use where it may be possible to use raised advertisement boards. For the purposes of this study high-level advertising boards have been chosen for examination. In the event that video advertising is used in a busy urban environment to gain drivers' attention, larger video boards would be more likely to distract a driver.

As previously mentioned in this section, there are a limited number of research articles related directly to advertising and driver distraction. However, one relevant example is the work of Ady (1967). The research examined a number of advertisements along a particular route and the collision rate of that road. It was discovered that one brightly lit advertisement, located on a sharp bend, had a significantly higher crash rate in the area around it. This was used as an example in the Wallace (2003) review of drivers response to advertisements, which brought forward the idea that a driver can be 'overloaded' with irrelevant information at critical times during a route.

The most recent study in this area, and the perhaps the most relevant to this current study, was conducted by Young and Mahfound (2007). The research assessed the effects of roadside advertising on driver attention and performance. The research attempted to examine a range of different road types; Urban, Motorway, or Rural. The study involved 48 participants. Data collected included:

- Driving performance – longitudinal and lateral control
- Driving attention – subjective mental workload, gaze behaviour, recall tasks based on road signs / billboards

The study found that the presence of billboards had a detrimental effect on lane position control, and also appeared to increase crash risk. This may have been due to increased driver workload, which was shown to significantly increase when advertisements were present. The results of the study did not find that drivers looked at advertising more in any particular driving environment. However the number of fixations significantly increased when billboards were present, highlighting a possible change in drivers' scan patterns when advertising was present.

Young and Mahfound demonstrated that roadside advertising could affect driver attention, and thus affect driving performance. There was clear evidence of a change in a drivers' visual search patterns around advertising.

When examining the process of distraction and its effect on driving, it is important to separate two key processes. The first is that distraction can affect a drivers' ability to control the car effectively potentially resulting in poor road positioning or loss of control. The second is that any increased cognitive load will increase reaction time to any discrete reaction task. In the context of driving, this can be seen as a need to brake or swerve to avoid collision with an obstacle (i.e. pedestrian, other car). This study aimed to collect both collect information on a driver's visual behaviour and data on their ability to control the vehicle while driving though the environment. The driven route included a number of pre-programmed events that required a driver to respond by braking. Performance in the presence or absence of various advert configurations was compared. These events varied in type, in some instances it was a pedestrian crossing the road, in others a car braking or changing direction. This gave vital information on a driver's comparative ability to respond in safety critical situations in the presence of billboard adverts.

<u>The key research questions that have been addressed in this study are</u>:

1. What effect does advert presentation mechanism (static vs. video) have on driver distraction?
2. How does driver distraction vary in relation to exposure time to adverts?
3. What effect does advert position have on driver distraction?
4. Where possible, relationships between the variables were determined.

2 Content Validation Study

2.1 Aims

It was important to use a range of different advertisements in the simulator study, since a single advertisement displayed throughout the trial would lose its capacity to attract the driver's attention. However, it was also necessary to ensure that the advertisements used within the study displayed similar conspicuity levels, since results could potentially be confounded if some of the advertisements captured attention much more readily than the others. A pre-trial content validation study was undertaken to select one set of static advertisements and one set of video advertisements such that items within each set had similar conspicuity levels. The objective of the study was to present participants with advert pairs and to ask which advert of the pair participants found most captured their attention. It was predicted that this would enable selection of a set of static and video adverts that were (approximately) homogeneously conspicuous.

2.2 Method

2.2.1 Advertisements

In order to ensure the validity of the study, it was decided that images from current or past advertising campaigns should be used. Constraints for the advertisements were as follows:

- Advertisements must not be too dark to ensure that they are legible in the simulator environment.
- Static advertisements must be landscape images at a resolution of approximately 800×400 pixels.
- Video advertisements must be approximately 5 seconds long.
- Video advertisements must be of approximately 320×240 pixel resolution

A large number of static and video advertisements were downloaded from the internet. Many of these did not conform to the criteria set out above and were discarded. Video advertisements were edited to reduce their playing time to 5 seconds. A final set of 28 static and 24 video advertisements were included in the pre-trial content validation study.

The purpose of the content validation study was to present participants repeatedly with pairs of adverts (either static or video advertising – never a mixture of both types) and to ask participants which of the two adverts they found most captured their attention. This gave a total of 756 (28×27) pairs of static advertisements and 552 (24×23) pairs of video advertisements.

It was unrealistic to expect participants to view all combinations of both static and video advertisements; thus, the pairs were randomised and split into twelve blocks, each comprising 63 pairs of static advertisements and 46 pairs of video advertisements. Advert pairs were presented one above the other. Each advert appeared in upper and lower positions an equal number of times to control for any effects of advert position on relative conspicuity.

2.2.2 Participants

Participants were recruited to be representative of the population of drivers in London. Approximately equal numbers of male and female participants were recruited across a wide range of ages.

2.2.3 Trial procedure

A computer programme was specifically designed for the purpose of this study. The programme first displayed a start-up screen for the experimenter to input the participant's details. The next screen displayed instructions for the participant and would automatically maximise in order to control for the potential effects of desktop clutter. Participants viewed the adverts on a 17" flat panel monitor at a distance of 1m from the display screen. The adverts subtended a horizontal visual angle of 22.8º and a vertical visual angle of 11.4º. This is equivalent to viewing a 48 sheet (6.10m × 3.05m (20ft × 10ft)) billboard advert from a distance of 15.1m.

After reading the instructions, the participant clicked the 'Start' button and the program displayed two static advertisements one above the other on the screen (see Figure 2.1). The participant was asked to identify which image they found more 'attention-grabbing' by pressing either '1' or '2' on the keyboard to indicate their choice. Each pair of static advertisements was displayed for 2 seconds before a grey screen would ask for their input; it was possible to enter a choice while the images were displayed.

Figure 2.1: Screen displaying two static advertisements.

Once the participant had completed the first section displaying 63 pairs of static advertisements, a new instruction screen appeared. The participant then clicked the 'Start' button and the program displayed two video adverts, one above the other on the screen. Participants were again asked to identify which advert they found more 'attention-grabbing'. The video adverts were played simultaneously until they had both finished. Participants had to wait until both adverts had finished playing before a grey screen would be displayed, allowing them to enter their choice.

The program recorded participants' selection response to each pair along with their age group, gender and participant number.

2.3 Analysis and Results

Data analysis for the pre-trial content validation study was undertaken using SPSS for Windows. Chi square and Fisher's exact tests were used to explore the effects of age group and gender respectively on advertisement selection, and a univariate analysis of variance was conducted to compare the advertisements in terms of how attention grabbing participants found them. The results are presented in the sub-sections below.

2.3.1 Participant Profile

34 participants took part in the pre-trial content validation study. Table 2.1 shows that there was a similar number of males and females within the sample. While all age groups were represented, there were fewer participants from the highest and lowest age groups.

Table 2.1: Age and gender profile of participants

		Gender		
		Female	**Male**	**Total**
Age group	**17 – 25**	2	3	5
	26 – 40	6	8	14
	41 – 55	5	4	9
	56+	3	3	6
		16	18	34

2.3.2 Static Advertisements

28 static advertisements were presented to participants. A univariate analysis of variance showed a highly significant effect of the static advertisement itself ($F_{(27, 6580)}$ = 9.079, p < 0.01) on whether it was chosen or not, as well as highly significant interaction effects of:

- age and the static advertisement itself ($F_{(81, 6580)}$ = 2.739, p < 0.01) on whether the particular advertisement was chosen or not;
- gender and the static advertisement itself ($F_{(27, 6580)}$ = 1.039, p < 0.01) on whether the particular advertisement was chosen or not;
- age, gender and the static advertisement itself ($F_{(81, 6580)}$ = 2.672, p < 0.01) on whether the particular advertisement was chosen or not.;

Chi square tests showed that for six advertisements, age group had a significant effect on whether it was chosen or not. Fisher's exact tests revealed that the selection of seven advertisements showed a highly significant dependency on gender. Out of these, five showed a highly significant dependency on both age and gender; thus eight advertisements were eliminated from the shortlist to control for the effects of age and gender within the simulator trial. These are shown in Table 2.2.

Table 2.2: Static advertisements for which gender (using Fisher's exact tests) or age (using Chi-square tests) had a significant effect on selection

Advertisement	Gender	Age			
	p	df	N	χ^2	p
01.jpg	.001	3	248	26.623	<.001
02.jpg	<.001				
09.jpg	<.001	3	231	13.000	.005
11.jpg	.005				
14.jpg	.009	3	244	29.066	<.001
16.jpg	.004	3	239	31.400	<.001
18.jpg	<.001	3	238	18.812	<.001
28.jpg		3	245	19.562	<.001

A Tukey's HSD post-hoc test divided the static advertisements into ten homogeneous subsets in terms of how attention-grabbing participants found them. A minimum of 14 advertisements were needed for the simulator study. To minimise the variation between advertisements in terms of how attention-grabbing they were, a further six advertisements were eliminated. The remaining advertisements were distributed across four homogeneous subsets in terms of distraction. The figure below shows these advertisements on a scale representing the number of times the advertisement was selected by participants, divided by the total number of times it was presented.

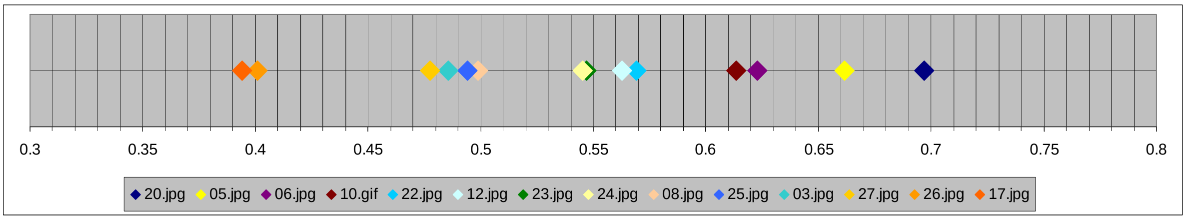

Figure 2.2: Subset of static advertisements selected for the simulator study

In summary, it was possible to control for the effects of age group and gender, and to reduce the variation in terms of distraction while selecting a subset of static advertisements to be used in the simulator study.

2.3.3 Video advertisements

24 full motion video advertisements were presented to participants, with a view to selecting fourteen of these for the simulator study. A univariate analysis of variance showed the following highly significant effect of the video advertisement itself ($F_{(23,\ 4776)} = 11.317$, $p < 0.01$) on whether it was chosen or not, as well as highly significant interaction effects of:

- age and the video advertisement itself ($F_{(69,\ 4776)} = 3.069$, $p < 0.01$) on whether the particular advertisement was chosen or not,
- gender and the video advertisement itself ($F_{(23,\ 4776)} = 3.772$, $p < 0.01$) on whether the particular advertisement was chosen or not,

- age, gender and the video advertisement itself ($F_{(69,\ 4776)}$ =2.165, $p < 0.01$) on whether the particular advertisement was chosen or not.

The selection of nine advertisements showed a highly significant ($p < 0.01$) dependency on age group, and eight showed a highly significant ($p < 0.01$) dependency on gender. The selection by participants of four advertisements showed a highly significant dependency on both age group and gender. These are shown in Table 2.3 below.

Table 2.3: Video advertisements for which gender (using Fisher's exact tests) or age (using Chi-square tests) had a significant effect on selection

Advertisement	Gender	Age			
	P	df	N	χ^2	p
04.wmv	<.001				
09.wmv		3	212	19.236	<.001
10.wmv		3	206	21.853	<.001
11.wmv		3	203	12.724	.005
13.wmv	<.001				
14.wmv	<.001	3	215	19.418	<.001
15.wmv	.007				
17.wmv	.003	3	205	37.978	<.001
18.wmv	<.001	3	205	30.392	<.001
19.wmv	<.001				
20.wmv	.001				
21.wmv		3	202	18.723	<.001
22.wmv		3	201	14.774	.002
24.wmv		3	.002	14.505	.002

It was not possible to eliminate more than fourteen advertisements to control for these two variables. Thus, a decision was made to control for the effects of age group and eliminate one further advertisement. '04.wmv' was eliminated as the selection of this advertisement was significantly dependent on gender; this also greatly reduced the variability between advertisements in terms of how attention grabbing participants found them.

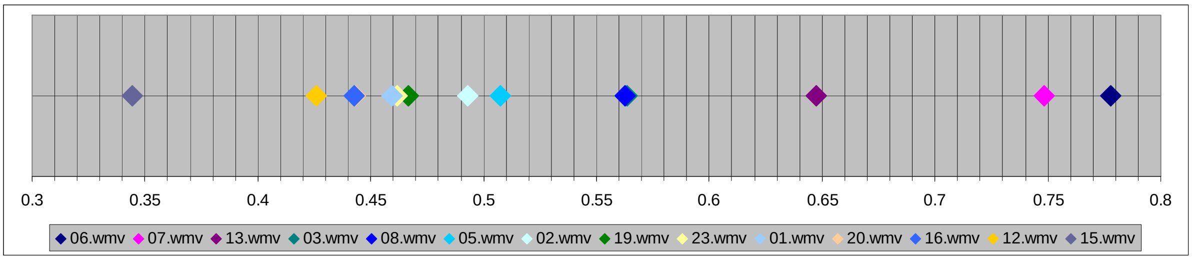

Figure 2.3: Subset of video advertisements selected for the simulator study

A Tukey's HSD post-hoc test had divided the static advertisements into nine homogeneous subsets in terms of how attention grabbing participants found them. The final selection of advertisements was distributed across eight homogeneous subsets. Thus, it was possible control for the effects of age group in selecting a subset of static advertisements to be used in the simulator study, and somewhat reduce the effects of gender and the variation between advertisements.

2.4 Conclusion

The content validation study enabled the selection of fourteen static adverts that were approximately matched in terms of their ability to attract the attention of male and female and older and younger viewers. A similar process identified fourteen video adverts that fulfilled the same criteria. As a result, these adverts could be presented in the driving simulator trial providing two important benefits:

- Participants would not become indifferent to the adverts (as they might if the same image were used repeatedly)
- Any differences seen in visual scanning patterns or driving behaviour can attributed more confidently to the configuration (rather than the content) of the advert.

3 Simulator Study

3.1 Aims

The simulator study was the focus of this project, in that the main aims of the project would be accomplished during this section of the study. The aims were to measure and compare the precise distraction levels caused by:

- Advert position (placement relative to the road)
- Advert type (static and video)
- Advert exposure duration (period over which the advert is visible)

3.2 Method

The study employed the TRL car simulator with a bespoke visual database of a dense urban environment, as well as the integrated, non-intrusive eye tracker. Simulator data was used to record and compare driving behaviour across experimental conditions. The eye tracker was used to measure how many times participants looked at the advertising billboards and how long they spent looking at them.

3.2.1 Simulator

The study employed the TRL car simulator running SCANeR II™ software provided by Oktal (see Figure 3.1).

Figure 3.1: TRL CarSim (displaying the simulated London database created for this project)

The simulator vehicle is a standard hatchback car and the controls are operated as in a real vehicle. The vehicle is mounted on four electric actuators connected to the axles behind each wheel to provide motion with three degrees of freedom (3DOF); heave, pitch, and roll. The simulator provides 210º forward field of view using three flat screens. A rear screen gives a 60º rearward field of view with a display that is adjusted to appear correct for each of the driving mirrors. Images are displayed at a resolution of 1280×1024 pixels per channel and updated at frame rate of 60Hz. Simulator data relating to participants' operation of the vehicle and the position of the vehicle relative to infrastructure and other traffic was recorded at 20Hz and used to compare driving behaviour across experimental conditions.

An integrated, non-intrusive SmartEye™ eye tracking system was used to measure the frequency and duration with which participants looked at the advertising billboards. The integration of the eye tracker and simulator meant that the simulation software could report the specific element within the simulated environment upon which the driver's gaze was fixated, greatly facilitating data capture and analysis. Further details about the simulator and facilities are provided in Appendix A.

3.2.2 Participants

48 participants were recruited to take part in the study. These were selected to cover a wide range of ages, experience levels and both male and female drivers.

3.2.3 Independent Variables

The three factors for analysis were Advert position; Advert presentation; and Advert exposure time.

3.2.3.1 Advert position

The distraction level of adverts was tested for four configurations of sign position on a building, billboard, overhead gantry, bridge or other infrastructure as appropriate. These are shown in Figure 3.2 (adverts are highlighted by yellow dashed boxes):

Position A: On a building to the left

Position B: On top of a gantry

Position C: On a building to the right

Position D: All three positions simultaneously

Figure 3.2: Examples of the four different advertising positions tested

3.2.3.2 Advert type

Two types of advert were tested in the trial – static adverts and video adverts. Static adverts were representative of a traditional 48 sheet (3.05m × 6.10m (10ft × 20ft)) billboard advert, displaying a simple combination of text and/or pictures that did not change. Video adverts were displayed on boards of equivalent size as those used for static adverts but repeatedly displayed short (up to 6 seconds) of motion picture adverts (similar to those that could be seen on a television).

3.2.3.3 Advert exposure time

Participants experienced three different exposure times to the adverts visible to the left of the driven route (position A; see Figure 3.2). These different exposure times were achieved by obscuring the advertisements using buildings placed at various distances from the target advert.

Adverts at all other presentation positions (positions B, C and D; see Figure 3.2) were viewed at the intermediate exposure time. However, the means by which the advert was obscured did differ across presentation positions. For adverts at positions A and C (left and right respectively) obscuration was achieved by the placement of buildings ahead of the target advert (see Figure 3.3).

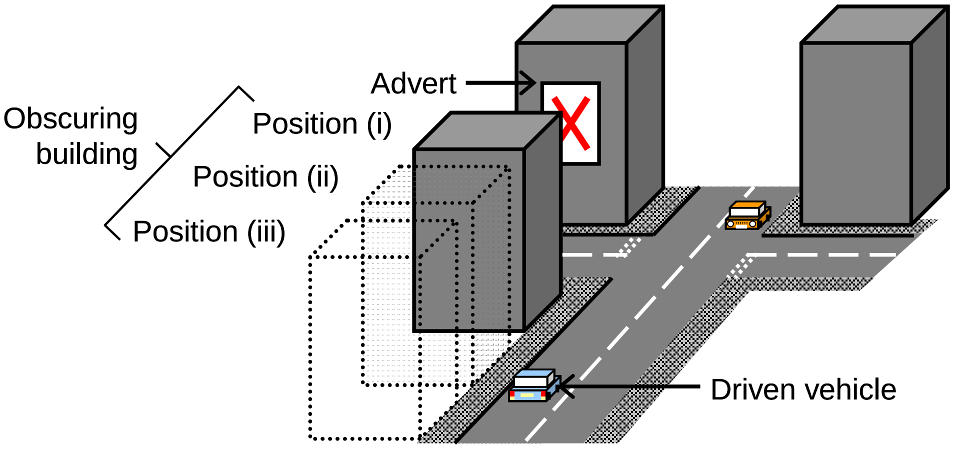

Figure 3.3: Layout of an advert presentation to demonstrate how exposure time variation was achieved through positioning an 'obscuring' building

For position B, in which the advert was positioned above the road, obscuration was achieved by the placement of an overarching structure (e.g. a bridge) ahead of the advert. For position D in which adverts are present to the left, to the right, and above the road, obscuration was achieved through curvature of the road such that the adverts were revealed to the driver as they proceeded along the trial route. To control for any differences in distraction caused by the direction of the bend used to obscure the adverts, participants viewed instances of this configuration from left and right bends with equal curvature.

3.2.4 Route Design

Participants drove each route in both directions, giving 4 drives per participant. Each route was approximately 13km in length, and at a steady speed of around 30mph, could be completed in approximately 15 minutes.

There were fourteen combinations of the three variables listed above; these are shown in Table 3.1.

Table 3.1: Summary table of the combinations of advert position, exposure time, and presentation mechanism

Configuration	Position	Exposure time	Presentation	Exposure time controlled by
1	Left (A)	Short (Position (i))	Static	Obscuring buildings
2			Video	
3		Intermediate (Position (ii))	Static	
4			Video	
5		Long (Position (iii))	Static	
6			Video	
7	Centre (B)	Intermediate	Static	Preceding bridge
8			Video	
9	Right (C)	Intermediate (Position (ii))	Static	Obscuring buildings
10			Video	
11	All 3 positions simultaneously (D)	Intermediate	Static	Road curvature (Left bend)
12			Video	
13			Static	Road curvature (Right bend)
14			Video	

Across the four drives, participants encountered each of these combinations twice; once with an accompanying event and once without. The events were used to compare the drivers' responses to hazards across different combinations of advertisements, and were designed in such a way that they would require a braking response from the driver. Four types of event were used:

1. The lead vehicle (vehicle immediately in front of the participant) braking sharply
2. A pedestrian walking into the road
3. The traffic lights changing from green to red
4. A car turning across the participant's path

Each of the four types of events was also repeated at a part of the route where there were no advertisements. These four situations were used as a baseline for identifying drivers' responses to hazards. To ensure that the traffic events were presented in a consistent manner for all participants, the speed of the simulator vehicle was artificially limited to 35mph throughout each drive.

In addition, participants also encountered four blank advertisement billboards across the four drives. These were included to permit analysis of distraction by a display with no advertising content.

3.2.5 Control data

It was found that there was a novelty effect associated with the use of blank billboards creating an associated distraction. This rendered them unsuitable for use in determining control behaviour.

To provide an alternative control dataset, further data analysis was performed, examining the 100m following each advertising board when driven in the reverse direction. For each advert present in the simulated route, driver behaviour was analysed in a 100m zone preceding the advert. Two different routes were used for the original trial and participants drove the two test routes in either direction giving four drives for analysis.

Control driving behaviour was defined as that observed when no adverts were visible. Since participants drove both routes in either direction, adverts visible when driving a route would not have been visible when driving the same route in the opposite direction. By analysing driver behaviour in the vicinity of the non-visible advert and comparing that to behaviour when the same advert was viewable, it was possible to obtain an estimate of the relative effect of static and video advertising on normal driving behaviour. Figure 3.4 below illustrates how the analysis region for control driving behaviour was defined.

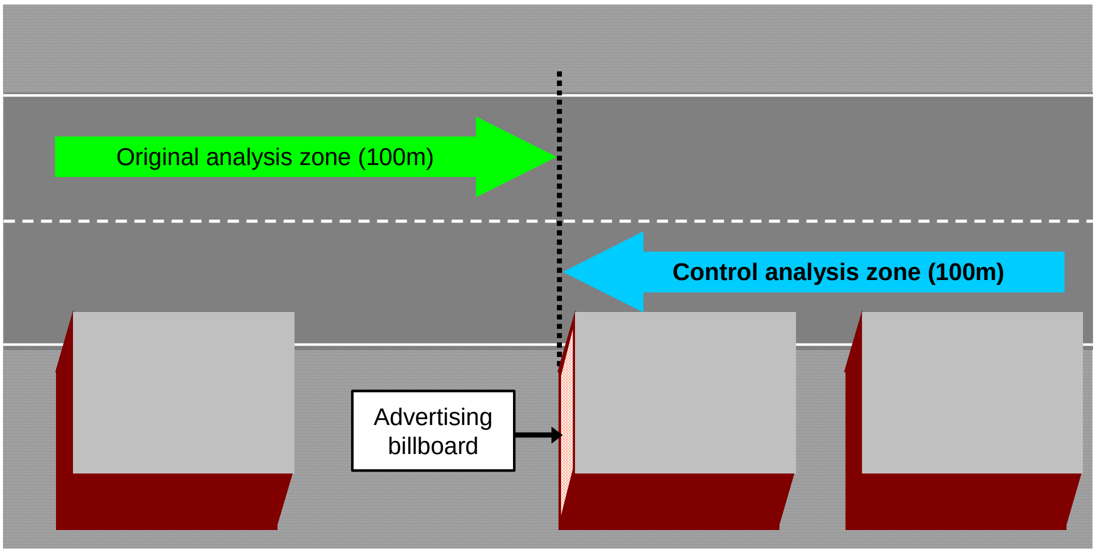

Figure 3.4: Definition of the 'control' analysis zone

By conducting the same analysis of behaviour in the 100m approaching the advert in the reverse direction, it was possible to compare driver performance when no advertising is visible, in similar road, traffic and visual cue conditions.

It is important at this point to highlight that it is not possible to analyse driver's visual behaviour. This is due to lack of any visual targets being present in the direction drivers were travelling when examining control data. With no visual targets present (i.e. advertising boards) it is not possible to record data on what drivers were looking at through the control 100m sections. However, all driving related measurements used in this study have been used within this analysis.

3.2.6 Statistical procedures

The statistical procedures used in the analysis are based on examining the differences between the different types of advertising, comparing these results to the way drivers behave when driving normally (with no advertising displayed). This has meant the Analysis of Variance test (ANOVA) is the most appropriate statistical analysis to conduct when examining duration and position effects.

When examining the effects of advertising position, the analysis is a 3×4 repeated measure ANOVA with planned contrasts. The analysis has been selected as there are three types of advert (control, video and static), and four different positions that the advertising can be positioned (all 3, centre, left, right). The analysis is a 'repeated-measures' design as the same task and measurements were used in each case, and each participant experienced all variations of advertising and position.

The statistical procedures used to examine the effects of advertising duration on driver behaviour differ slight from those used to assess positional effects. In this instance, data was examined using a 3×4 repeated-measures ANOVA. The reason this change was required was due to the number of variables decreasing. The data still contains three conditions (control, video and static), but now only three durations that were examined (short, medium, long). The analysis remains a repeated measures design, as the same method was used, as the same driver experienced all types of advertising, at each duration.

When comparing advert type, two additional datasets were created. These are "Control – Video' and 'Control – Static'. In order to make direct comparisons across advert types, and to ensure validity of the comparisons, control data was recorded separately for approaches to video adverts and to static adverts. This has resulted in the analysis being performed as a one-way ANOVA, with four variables. Planned contrasts have been performed to examine the statistical differences between each type of advertising and their respective control data.

Planned contrasts are used throughout the statistical analysis in this study, therefore it is important to state their purpose. Planned contrast analysis is an important test to conduct as the main ANOVA analysis simply identifies whether there has been an effect or impact of a type of condition change e.g. whether the type of advertising used impacts on mean speed or braking. Using this example, it is important to examine the data further to discover which type of advertising has the greatest effect. Throughout section 3.3 the results of any planned contrast have been included and the implications of the result explained.

3.2.7 Questionnaire

The objective data collected through the simulator and eye tracker were supplemented by subjective opinions of participants which were collected using questionnaires. A questionnaire administered after each drive, and a final questionnaire was administered at the end of the trials. These enquired about participants' recall of advertisements (and other elements of the route to ensure that the true purpose of the trial is not revealed), their mental workload during hazardous situations, how distracting they found video advertising and whether they felt such advertising billboards would have an effect on safety. Participants were not told the true nature of the trials until they had completed all four simulator drives.

3.2.8 Data collection and analysis

Table 3.2 shows the measures collected from the simulator trial at 20Hz throughout each simulator drive.

Table 3.2: Measures recorded during simulator trials

Measure	Unit of measurement	Description
Number of Glances	Count of glances at target	Number of times a driver has glanced at the advertising board
Mean Glance Duration	Seconds	The average amount of time that a person has spent looking at an advertising board
Percentage time looking at target	Percentage of time, time measured in seconds	The percentage of the time within 100m of an advertising board that a driver was looking at the advert
Time of Last Glance	Seconds	The amount of time that passed between the last glance at an advertising board and the point at which the driver had passed the board
Distance from Target to Last Glance	Metres	The distance between the driver and the advertising board at the point they made their last glance at the advert
Standard Deviation of Lane Position (SDLP)	Metres	The standard deviation of the driver's lateral lane position
Maximum Brake Position	0-1; where 0 = no pressure, 1 = maximum braking	The maximum depression of the brake pedal by the driver when braking in the area of an advertising board
Mean Speed	Miles per hour	The average speed of the vehicle during the 100m prior to an advertising board
Maximum Speed	Miles per hour	The maximum speed of the vehicle during the 100m prior to an advertising board
Standard Deviation of Speed	Miles per hour	The standard deviation of vehicle speed during the 100m prior to an advertising board
Object Contact	True or False	Information on whether a driver struck any object during the 100m approaching the advertising board
Deceleration Rate	Metres per second per second	Maximum deceleration rate achieved by the vehicle when braking in the area of an advertising board

Data was processed and analysed using Microsoft Excel 2003; statistical analyses were conducted using SPSS 14.0. Unless otherwise stated, all graphs within the results section of this report display the 95% confidence interval for each mean. The datasets were analysed to ensure they met the assumptions of parametric data, where this was not the case non-parametric statistics were used.

3.3 Results

3.3.1 Participants

In total, 55 participants were recruited to take part in the trials. Eight participants were unable to complete the trial due to symptoms of simulator sickness[1]. Data collection failed for one participant due to technical problem. This resulted in a total participant number of 46 (27M, 19F; mean age = 44.6 years, SD = 16.8). Table 3.3 shows the distribution of participants across age groups.

Table 3.3: Breakdown of participants by age group and gender

	Age group				
	17-25	**26-40**	**41-55**	**56+**	**Total**
Male	6	6	8	7	27
Female	3	4	7	5	19
Total	9	10	15	12	46

For the main factors of advert type, advert exposure duration and advert position, results for eye movement measures are presented first and driving behaviour results as determined from the simulator measures are presented after. Throughout and where possible, performance in relation to advert type is compared and this is analysed with reference to the control data.

3.3.2 Advert type

The following subsections examine the effect of advert type (video vs. static) on visual and driving behaviour.

3.3.2.1 Eye movement measures

Table 3.4 shows drivers' observed visual behaviour with static and video adverts and the results of t-test comparisons across the factor of presentation type.

Table 3.4 shows there were a number of significant differences in participants' visual behaviour found when comparing video and static advertising. Drivers looked at video advertising boards significantly more frequently ($t_{(1,530)} = 5.714$, $p < 0.001$) and for longer ($t_{(1,530)} = 2.925$, $p < 0.004$) than when passing static advertising. In percentage terms, drivers looked at video advertising for 12% longer, and on average made 34% more glances at the advertising.

[1] This is an unusually high dropout rate for simulator drives in TRL's CarSim (usual dropout rate is around 1-2%). It is believed that it was caused by the high level of detail created in the virtual urban environment and the frequent stopping/starting and changes of direction (typical of urban driving).

Table 3.4: Descriptive simulator statistics and results of t-test comparisons (Video vs. Static)

	Unit	Mean	N	SD	t	df	p
Number of Glances – Video	Count	1.67	531	2.83	5.714	530	**<0.001**
Number of Glances – Static		1.11	531	2.28			
Mean Glance Duration – Video	sec	0.27	145	0.22	-0.228	144	0.820
Mean Glance Duration – Static		0.28	145	0.35			
% time looking at target – Video	%	4.50	531	9.37	2.925	530	**0.004**
% time looking at target – Static		3.51	531	9.21			
Time of last glance – Video	sec	3.15	114	2.22	-0.567	113	0.572
Time of last glance – Static		3.31	114	2.07			
Distance to target last glance – Video	metres	33.89	114	20.02	-1.473	113	0.144
Distance to target last glance – Static		37.33	114	21.92			

3.3.2.2 Simulator measures

Maximum deceleration rate

Figure 3.5 shows the mean of maximum deceleration rate of the driven vehicle in the 100m approaching static and video adverts compared to that observed in the control dataset for each advert.

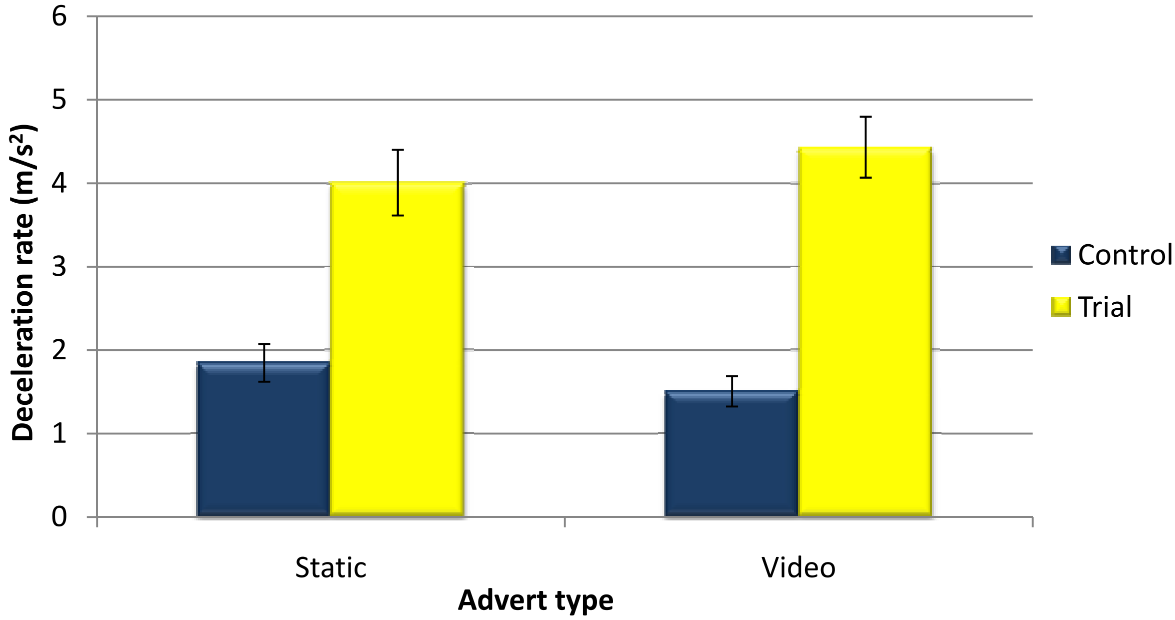

Figure 3.5: Maximum deceleration rate on approach to static and video adverts vs. control data

The one-way ANOVA conducted on maximum deceleration data indicated there was a significant main effect of advert type ($F_{(3,1317)} = 7.15$, $p < 0.001$). This suggests that the advert type influences the rate at which drivers' choose to decelerate. Figure 3.5 indicates that there was a greater maximum deceleration when advertising was present, and that the maximum deceleration was at its greatest when approaching a video advert.

The planned contrasts performed on this data set indicated that there was a statistical difference seen when advertising was present, and the effect was at its greatest when comparing control data to video advertising. Drivers approaching video advertising slowed the vehicle at a significantly greater rate than drivers braking around static advertising. This pattern of behaviour may be due to the driver being distracted by the advertising and braking at a later point.

Summary

- Results indicate adverts had a large effect on drivers' braking behaviour; the presence of *any* adverts influenced braking behaviour
- Static adverts decrease braking performance when compared to a situation where no adverts were present
- Video adverts were responsible for the greatest change in driver behaviour, with a significant decrease in performance when compared a situation where static adverts were present

Maximum speed

Figure 3.6 shows the mean of the maximum speed observed on approach to each advert type.

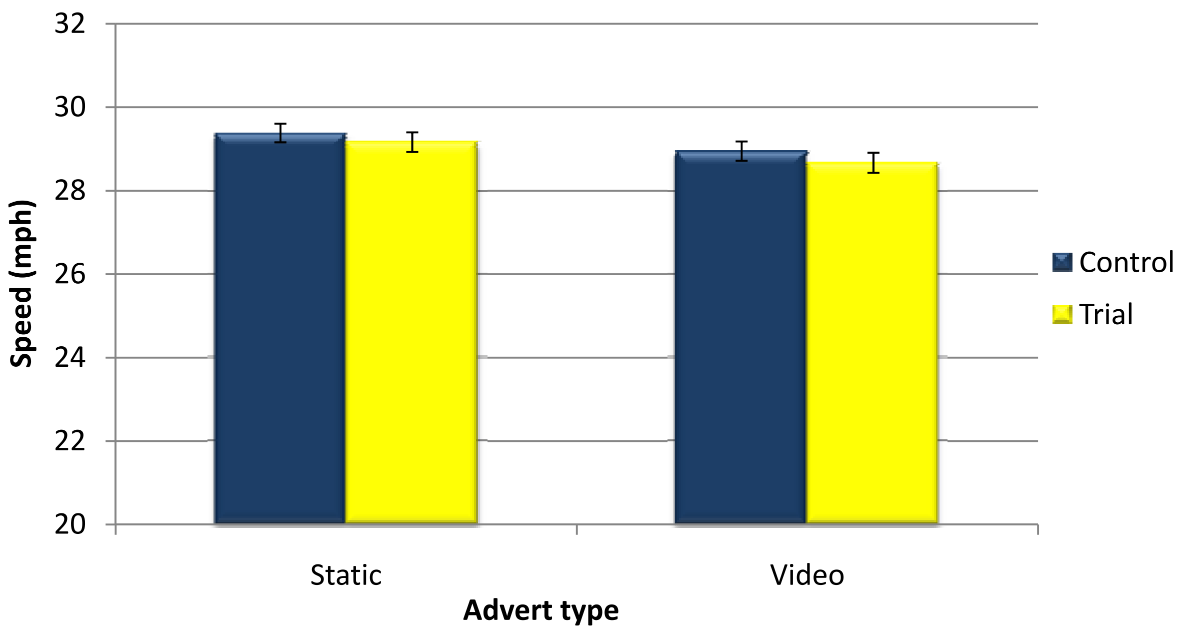

Figure 3.6: Maximum speed on approach to static and video adverts vs. control data

The one-way ANOVA analysis performed on maximum speed data collected during the course of this trial indicated there was a significant main effect of advert type ($F_{(3,1317)} = 22.21$, $p < 0.001$). The result of the planned contrast analysis indicated that results for video and static conditions differed significantly from the control data. This suggests that when advertising is present drivers achieve a lower maximum speed on approach. The results also indicate that when comparing the different types of advertising used, that drivers have a slightly but significantly lower maximum speed when passing video adverts.

Summary

- Results indicate that the presence of *any* adverts has an effect on drivers' speed selection behaviour
- When advertising was present, there was a small but significant reduction in drivers' maximum speed compared to a situation where adverts were not present. This was seen in both video and static advert conditions
- Video adverts were responsible for the greatest change in speed selection behaviour, with a significant decrease in maximum speed when comparing a situation where static adverts were present

Mean speed

Figure 3.7 shows the mean speed observed on approach to each advert type.

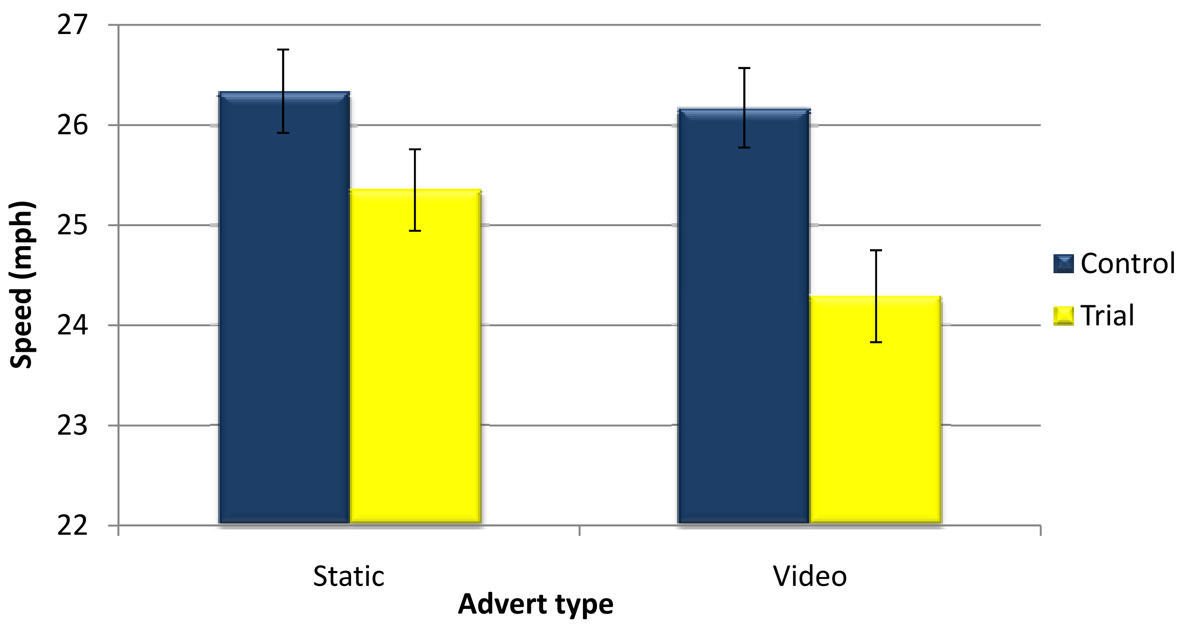

Figure 3.7: Mean speed on approach to static and video adverts vs. control data

Statistical results for mean speed indicate there was a main effect of advertising ($F_{(3,1327)} = 87.71$, $p < 0.001$). This effect indicates that the advert type impacts on the average speed a driver maintains in the period approaching an advert. As in the case of maximum speed, average speed was shown to be significantly higher in the control data set. This result suggests that the presence of any type of advertising causes a decrease in mean speed in the area prior to the advertising placement. Both types of advertising cause a decrease in average speed, but video advertising causes the greatest decrease ($p < 0.001$).

<u>*Summary*</u>

- Results indicate that the presence of *any* adverts has an effect on drivers' speed choice
- When advertising was present, drivers' mean speed decreased significantly compared to a situation where adverts were not present. This was seen in both video and static advert conditions
- Video adverts were associated with the greatest decrease in mean speed, highlighting a significant change in behaviour when comparing to a situation where static adverts were present

Standard deviation of speed

Figure 3.8 shows the mean of the standard deviation of speed observed on approach to each advert type.

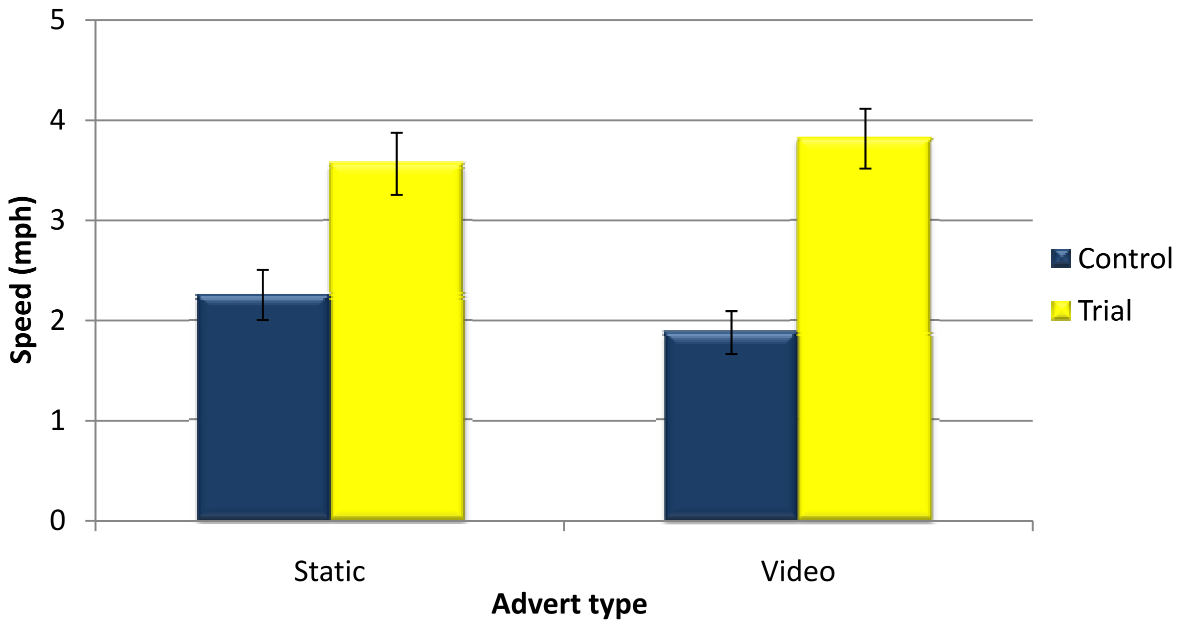

Figure 3.8: Standard deviation of speed on approach to static and video adverts vs. control data

Statistical results when comparing the standard deviation of speed around advertising boards, compared to a control data set, indicated that there was a significant main effect of advertising ($F_{(3,1317)} = 19.72$; $p < 0.001$). This shows that the presence of advertising causes an increase in speed variability. The planned contrasts also indicated that video advertising affects speed variability significantly more than static advertising ($p < 0.001$).

<u>*Summary*</u>

- Results indicate that the presence of *any* adverts has an effect on drivers' speed selection behaviour
- When adverts were present, drivers' speed variability increased significantly compared to a situation where adverts were not present. This was seen in both

video and static advert conditions. This suggests that the distraction caused by advertising affects a driver's ability to maintain a safe and constant speed

- Video adverts were linked with the greatest increase in speed variability, highlighting a significant change in behaviour when comparing to a situation where static adverts were present

Standard deviation of lateral lane position

Standard deviation of lateral position (SDLP) is a common measure used in simulator studies to assess the driver's ability to keep control of the vehicle. Poorer control is associated with higher variability, leading to a higher standard deviation in the measure of lateral position. Figure 3.9 shows the mean of the standard deviation of speed observed on approach to each advert.

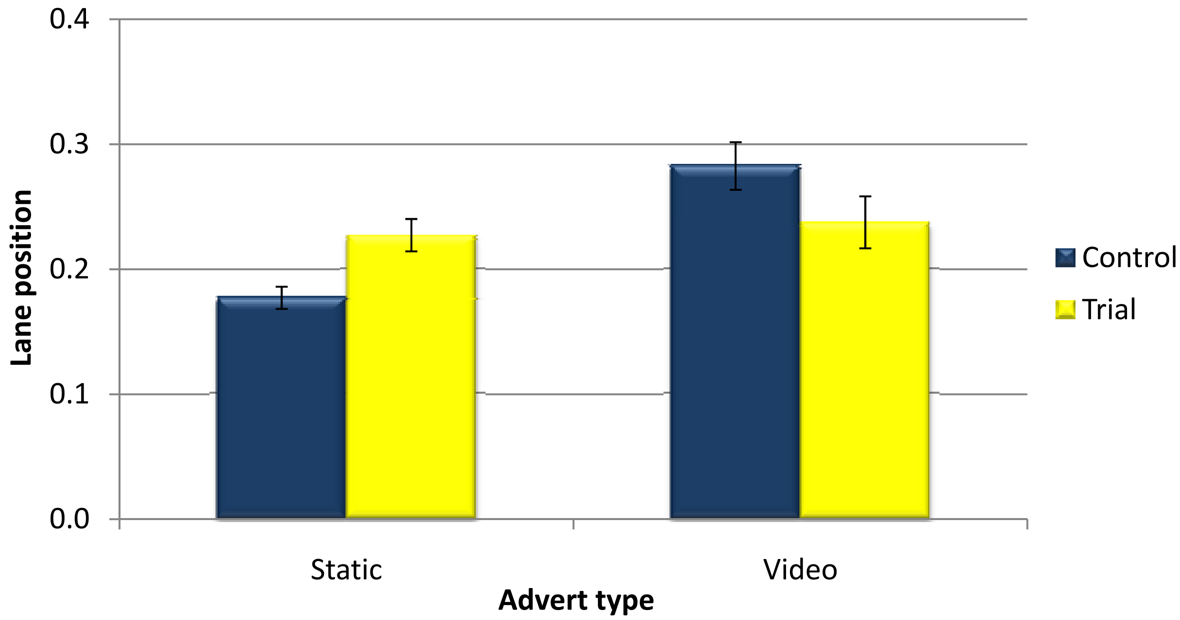

Figure 3.9: Standard deviation of lateral lane position on approach to static and video adverts vs. control data

The one-way ANOVA analysis performed on the data presented in Figure 3.9 indicated that there was a significant main effect of advert type ($F_{(3,1327)} = 79.67$, $p < 0.001$).

From the planned contrasts performed it is clear that when approaching a static advertising board, drivers' lane position varies significantly more than when no advertising was present. However, when comparing the control data from around video adverts to the actual trial data for video adverts, there is no significant difference (p = 0.12). There is a significant difference between the static control data and the video condition. It may be the case that, in the control direction for video advertising, there was some feature in the trial design that influenced driver's lane behaviour. This will be discussed in section 4.2.

Summary

- Results indicate that the presence of *any* adverts has an effect on drivers' ability to maintain a consistent lane position
- Video adverts cause greater SDLP than static adverts but this is cannot be verified with the control data

3.3.3 Advert exposure duration

The following subsections examine the effect of advert exposure duration on visual and driving behaviour. Note that exposure duration was only compared for adverts presented to the left of the driven lane (position A).

3.3.3.1 Eye movement measures

Mean glance duration

Figure 3.10 shows participants' mean glance duration to static and video adverts across the factor of exposure duration.

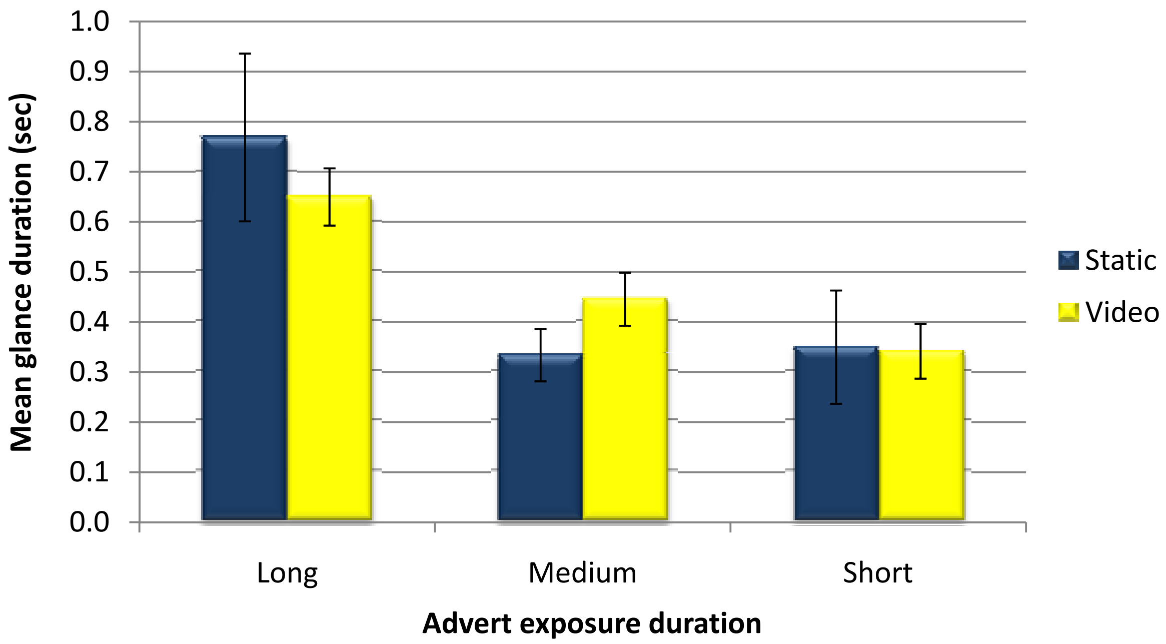

Figure 3.10: Mean glance duration at static and video adverts across advert exposure duration

When examining glance duration, there was a main effect of duration ($F_{(1,71)} = 5.65$, $p < 0.05$). This effect indicates that the length of time a driver will look at an advert (each individual glance) is influenced by the duration over which the advert is visible on approach.

Planned contrasts revealed that there was a significant difference between video and static adverts in the medium duration configuration ($p < 0.05$). This suggests that drivers approaching a medium duration advert will produce significantly longer glances to a video advert when compared to static advertising in the same placement. There was no significant difference between video and static conditions when a long or short duration advertising board was being approached.

<u>*Summary*</u>

- Drivers looked at medium duration video adverts significantly longer than static adverts in the same position
- Drivers approaching an advert that was visible for the long duration looked at it significantly longer than adverts visible for a medium or short duration

Percentage time looking at advertisement

Figure 3.11 shows the mean of the percentage of time that participants spent looking at static and video adverts across the duration conditions.

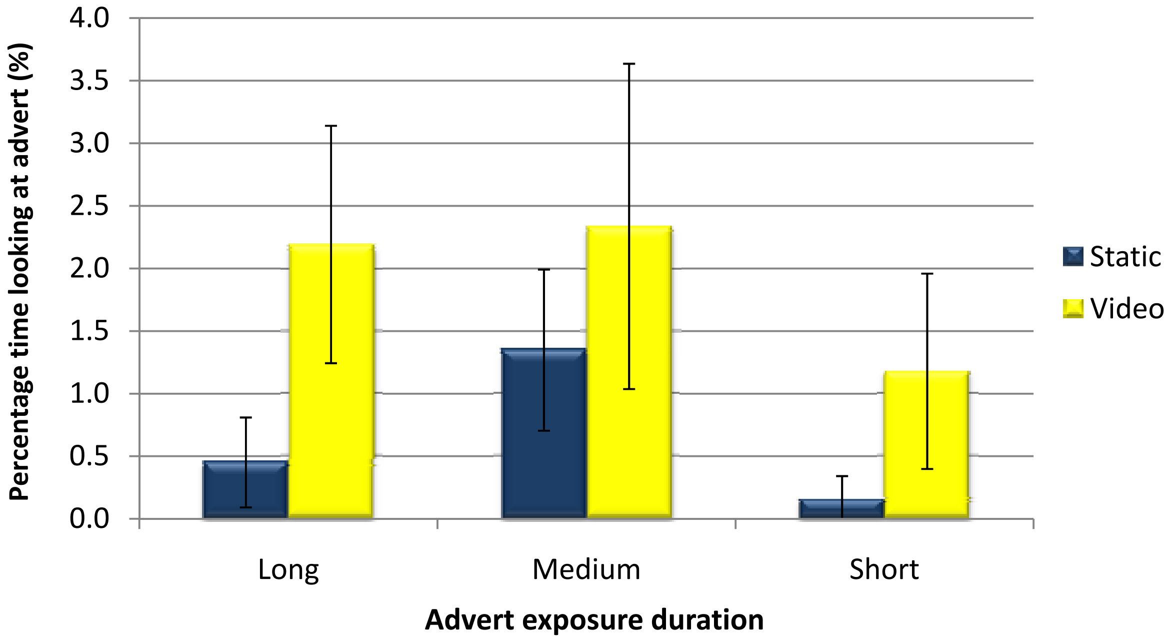

Figure 3.11: Mean percentage of time looking at static and video adverts across advert exposure duration

The statistical analysis of percentage time looking at a particular advert type and the relationship with the duration of advertising visibility indicated that there were two significant effects within the data. The first main effect was advert type ($F_{(1,72)}$ = 12.52, p < 0.005, 1-β = 0.94), and the second was advert exposure duration ($F_{(2,144)}$ = 7.06, p < 0.005, 1-β = 0.93). These effects indicate that the portion of time on approach to an advertisement where a driver will look at the advert is affected by both advert type and advert exposure duration. Figure 3.11 shows that participants spent a greater percentage of the approach looking at video adverts. The planned contrasts conducted as part of the ANOVA indicated that there were significant differences in all three duration conditions (p < 0.01).

Summary

- Drivers looked at video adverts significantly more than static adverts, independent of advert exposure duration
- Drivers spent significantly more time looking at adverts on approach if they were in the long or medium advert exposure duration

3.3.3.2 Simulator measures

SDLP

Figure 3.12 shows participants' mean SDLP on approach to adverts and compared to control data across the factor of advert exposure duration.

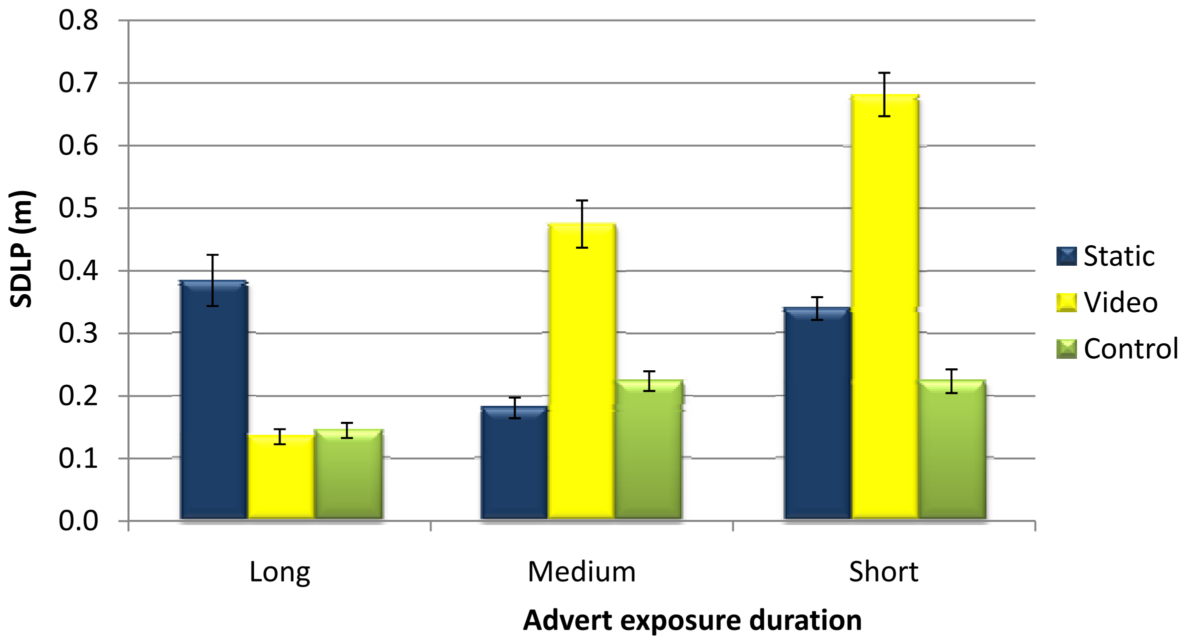

Figure 3.12: Mean SDLP for static and video adverts vs. control data across advert exposure duration

The ANOVA performed on this data set, including control data, indicated that there was a main effect of advert type ($F_{(2,120)} = 150.63$, $p < 0.001$). There was also a main effect of advert exposure duration ($F_{(2,120)} = 118.79$, $p < 0.001$). An interaction effect was also identified ($F_{(4,240)} = 142.38$, $p < 0.001$). In the long exposure condition, there was very little difference between the control data set and the video advert condition but significant differences ($p < 0.005$) were found for both the medium and short conditions. For the short duration, it was also found that SDLP was significantly higher when around both advert types. This indicates that any form of advert being present caused the driver's lane position to become increasingly variable.

The planned contrasts performed on the data showed a significant difference between video and static advertising at all three durations ($p < 0.001$). The contrasts also showed that there was no significant change in SDLP across durations for static adverts. However, SDLP was significantly different for all comparisons of exposure duration for video adverts ($p < 0.01$) showing a trend of increasing lateral position variability as advertising duration decreases.

Summary

- Advert type and exposure duration affect a driver's ability to maintain a consistent lane position
- Lane position variability was significantly increased in drivers approaching video adverts; this was when compared to both static adverts and control data
- This effect is not seen for video adverts visible for the long duration but is a significant effect is observed for static adverts at this position

Mean speed

Figure 3.13 shows participants' mean speed on approach to adverts and compared to control data across the factor of advert exposure duration.

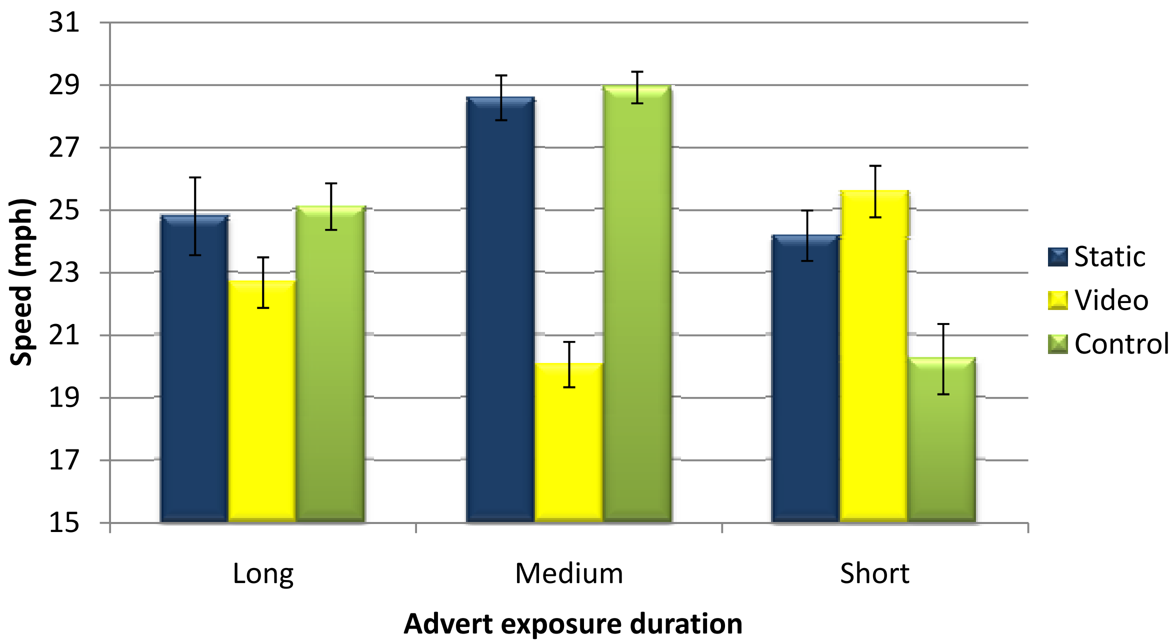

Figure 3.13: Mean speed on approach to static and video adverts vs. control data across advert exposure duration

The ANOVA comparing the data found a main effect of advert type ($F_{(2,120)} = 44.67$, $p < 0.001$) and advert exposure duration ($F_{(2,120)} = 13.88$, $p < 0.001$). There was also an interaction effect of advert type and exposure duration ($F_{(4,240)} = 73.08$, $p < 0.001$).

The planned contrasts show that control data was significantly different compared to video adverts with static advertising showing no difference at any duration. The largest difference between control and video data was during the medium condition ($p < 0.001$). The planned contrasts performed as part of the ANOVA indicated that there was a significant difference between the average speed of the video and static group in the long and medium exposure duration conditions ($p < 0.01$). This suggests that the static group maintained a higher average speed in the 100m approaching the advertising boards. From Figure 3.13, it is clear that the speed differential tended to be greatest for adverts presented at the medium exposure time. The contrasts also indicated that the difference seen in mean speed observed for short exposure duration adverts was not significantly different. In general, it seems that speed choice with static adverts is more similar to the control condition than that observed with video adverts.

Summary

- Advert type and exposure duration affect a driver's speed choice
- When approaching video adverts of long or medium visibility durations, mean speed was significantly lower when compared to static adverts
- The lower mean speed suggests participants slowed to view the adverts
- Speed differential was greatest for video adverts in the medium exposure time condition

Maximum speed

Figure 3.14 shows participants' maximum speed achieved on approach to adverts and compared to control data across the factor of advert exposure duration.

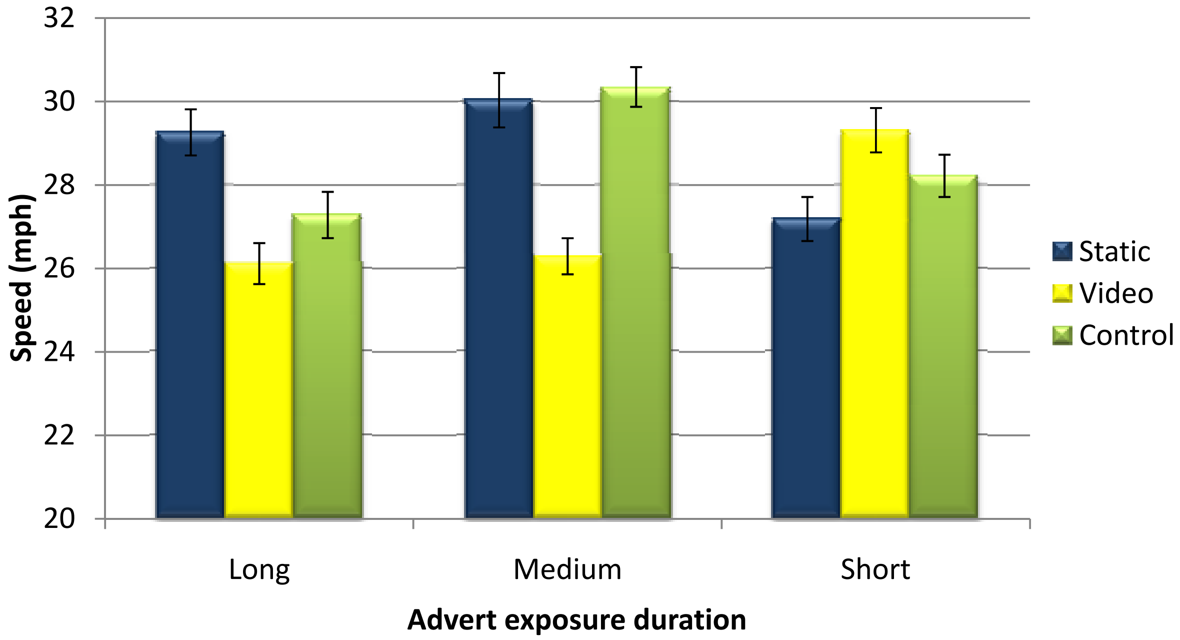

Figure 3.14: Maximum speed on approach to static and video adverts vs. control data across advert exposure duration

The ANOVA performed on data for maximum speed during the 100m prior to an advert indicated that there was a main effect of advert type ($F_{(2,120)} = 55.23$, $p < 0.001$). There was also a main effect of advert exposure duration ($F_{(2,120)} = 27.79$, $p < 0.001$), and an interaction effect ($F_{(4,240)} = 57.86$, $p < 0.001$).

Control data was shown to be significantly different from video data during the long and medium durations ($p < 0.01$ in both instances). For adverts at the short exposure time, there was a significant differences observed between static or video adverts when compared to the control data, with the video condition seeing higher speeds than both control and static advertising. Planned contrasts indicated that there was a significant difference between the video and static group in the long and medium conditions ($p < 0.01$) with participants achieving a higher maximum speed for static adverts.

Summary

- Advert type, and exposure duration affect a driver's speed choice
- When approaching adverts of long or medium durations, the maximum speed achieved by drivers approaching video adverts was found to be significantly lower than around static adverts
- The lower maximum speed suggests participants slowed to view the adverts

Standard deviation of speed

Figure 3.15 shows the mean of the standard deviation of speed observed on approach to adverts and compared to control data across the factor of advert exposure duration.

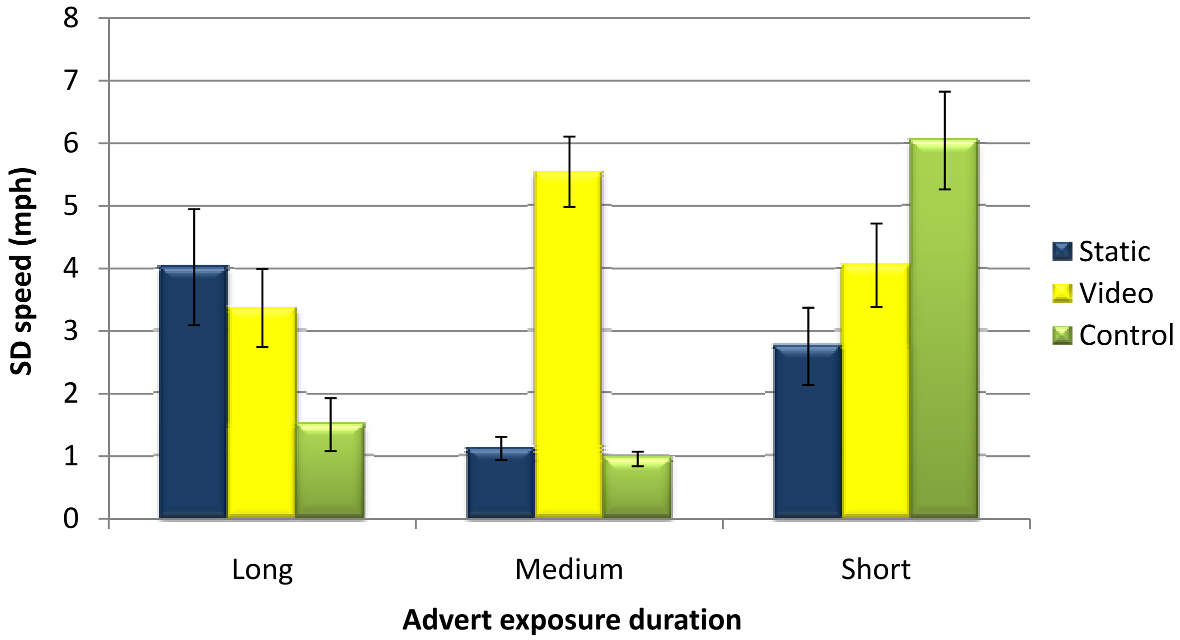

Figure 3.15: Standard deviation of speed on approach to static and video adverts vs. control data across advert exposure duration

The statistical analysis of data there was a main effect of advert type ($F_{(2,120)} = 27.98$, $p < 0.001$) and of advert exposure duration ($F_{(2,120)} = 11.25$, $p < 0.001$) and an interaction effect between the two ($F_{(4,240)} = 39.63$, $p < 0.001$). This result suggests that both factors influence drivers' control of speed, with some combined effects of both advert type and duration being present in some cases. The planned contrasts performed as part of the analysis indicated that there were significant differences between video and control data in the medium condition and long condition ($p < 0.01$). There were also significant difference between control and static advertising groups during the long exposure condition ($p < 0.005$).

There was no significant difference between video and static advertising when the advertising duration was long. It is possible that drivers had difficulty differentiating video and static adverts from long distances or advert type did not affect how they attended to the advert at distance. In either case, a driver would be unlikely to change their behaviour at distance across the factor of advert type. However, when the advertising board was visible for a medium duration, there was a significant difference between video and static groups ($p < 0.001$). This indicates that when approaching video adverts, drivers showed a significantly higher variability in their speed. The planned contrast analysis also indicated there was a significant difference between video and static groups in the short visibility condition ($p < 0.05$), this is clearly seen in Figure 3.15.

Summary

- Advert type and exposure duration affect a driver's ability to maintain a consistent speed
- When approaching video adverts, drivers showed a significantly higher variability in their speed for the medium and short exposure durations

- This may have been a consequence of slowing to view the adverts
- Video adverts affect a drivers' ability to maintain a constant speed, especially in the medium duration condition

Maximum deceleration rate

Figure 3.16 shows the mean of the maximum deceleration rate observed on approach to adverts and compared to control data across the factor of advert exposure duration.

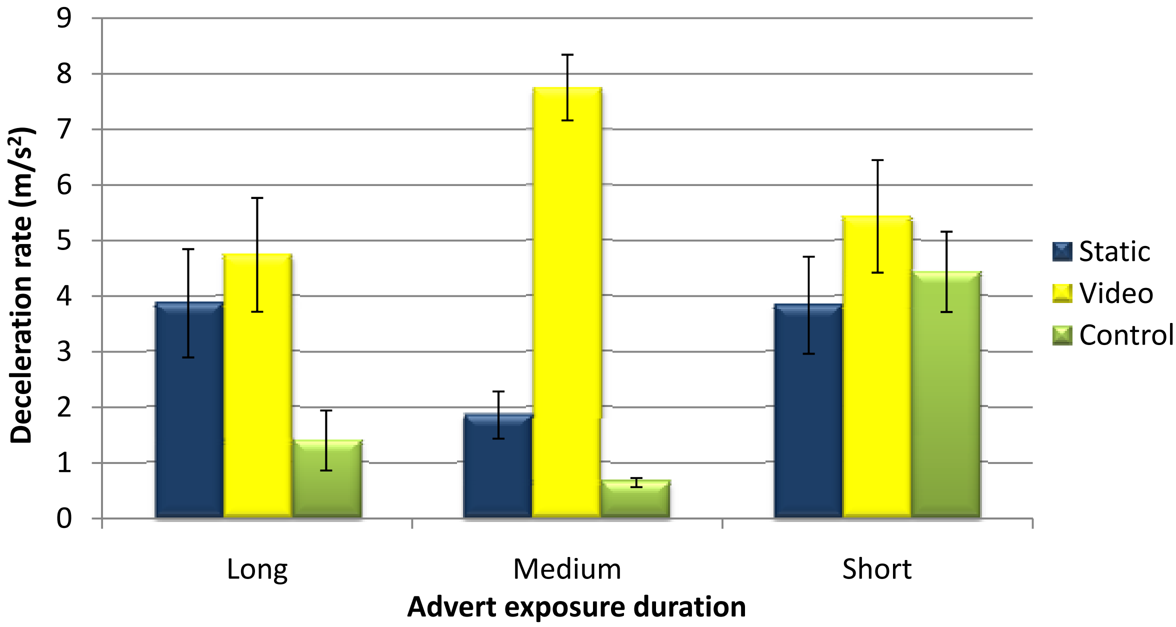

Figure 3.16: Maximum deceleration rate on approach to static and video adverts vs. control data across advert exposure duration

The results from the ANOVA analysis of this data shows there is a main effect of advert type ($F_{(2,120)}$ = 80.01, p < 0.001), advert exposure duration ($F_{(2,120)}$ = 3.83, p = 0.024, 1-β=0.69) and an interaction effect between the two ($F_{(4,240)}$ = 17.36, p < 0.001). The contrast analysis performed on the data indicated there were significant differences between control braking behaviour and maximum deceleration rate when adverts were present.

In both the long and medium conditions there were significant differences between control data and data for both video and static adverts, suggesting that drivers slowed at a significantly higher rate when approaching advertising (p < 0.001). Video advertising was also significantly different from control behaviour in the short exposure condition (p < 0.05). Planned contrasts indicated there was no significant difference between the deceleration rates for video and static groups when approaching a long duration advert. However, there was a significant difference between the video and static adverts in the medium duration condition (p < 0.01). This suggests that the deceleration rate was significantly greater when on approach to a video advert and that the exposure duration influences whether this difference is significant.

<u>*Summary*</u>

- Advert type and exposure duration affects the deceleration rate chosen by a driver to stop if braking was required

- Drivers approaching video adverts showed the highest deceleration rate in all three advert exposure durations
- The difference between video adverts and the other conditions examined was greatest in the medium advert exposure duration
- Results suggest that participants slowed to view the adverts, particularly video adverts at the medium exposure duration

3.3.4 Advert position

The following subsections examine the effect of advert position on visual and driving behaviour.

3.3.4.1 Eye movement measures

Mean number of glances at adverts

Figure 3.17 shows the mean number of glances made by participants on approach to static and video adverts compared across the factor of advert position.

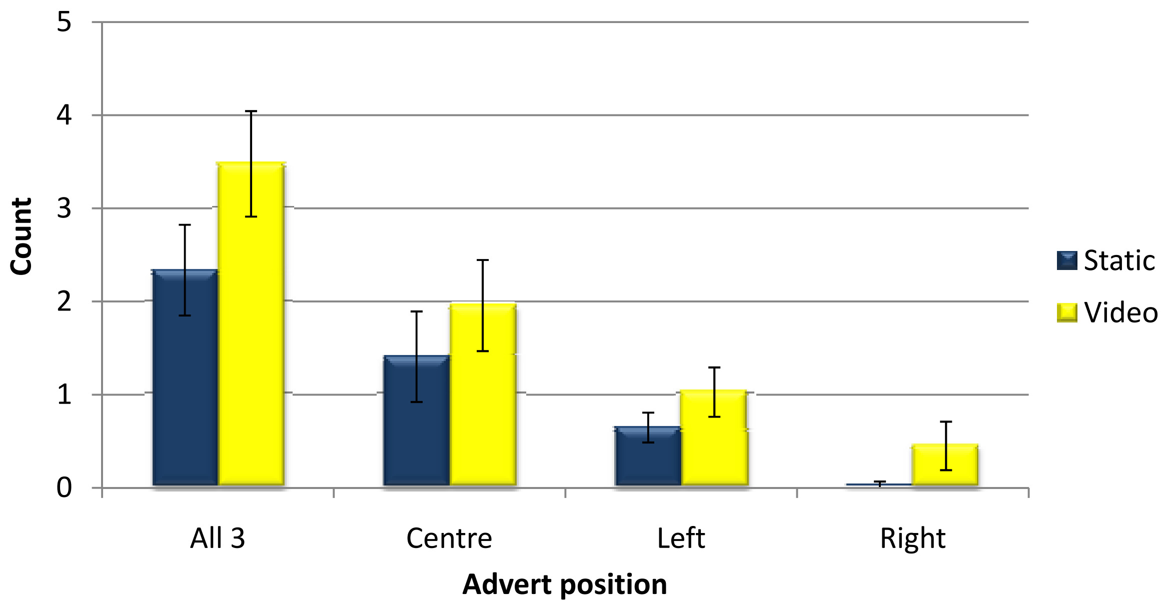

Figure 3.17: Mean number of glances at static and video adverts across advert position

The repeated measures ANOVA performed on this data set revealed a significant main effect of advert type ($F_{(1,72)}$ = 13.26, p < 0.001), and an interaction effect of advert type and position ($F_{(2,144)}$ = 12.96, p < 0.001). This analysis has indicated that the type of advertisement used affects that number of glances a driver will make at the advertisement position. The results also suggest there is a link between advert type and where the advert position that influences visual behaviour.

The planned contrasts performed as part of the ANOVA indicated there was a significant difference between video and static adverts in all four positions (p < 0.01). This suggests that regardless of position, drivers make more glances to video adverts than to static adverts. The statistical tests indicate there are significant differences in the number of glances made to each position for video and static adverts. This suggests that drivers make the greatest number of glances to advertising placed in all 3 positions, with significantly fewer glances to centre, left and then right advert positions.

Summary

- Advert type was found to have a significant effect on the number of times a driver will look at an advert
- Drivers looked at video adverts significantly more than static adverts, regardless of the position adverts were placed
- The results suggest that the number of glances made at adverts reduced when adverts were placed at the side of the road rather than directly over the carriageway or in all three positions

Mean glance duration

Figure 3.18 shows the mean duration of glances made by participants on approach to static and video adverts compared across the factor of advert position.

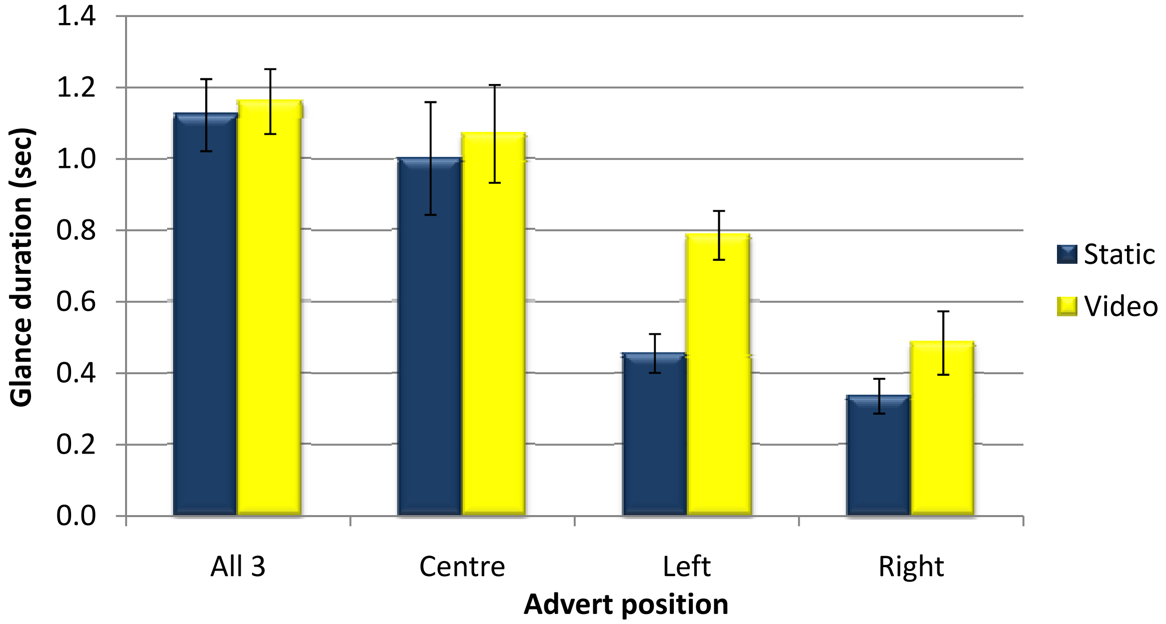

Figure 3.18: Mean duration of glances at static and video adverts across advert position type

Figure 3.18 shows that at all positions, mean glance duration was higher to video adverts. A repeated measures ANOVA indicated that there was a significant main effect of the advert type ($F_{(1,70)} = 15.06$, $p < 0.001$), and a main effect of advert position ($F_{(3,210)} = 57.47$, $p < 0.001$). These results therefore suggest that average glance duration is significantly influenced by advert type and advert position.

As part of the ANOVA, planned contrasts were conducted which indicated there was no difference in the mean glance duration for video and static adverts between the all 3 position and the centre position. However, there was a significant difference in the mean glance duration between video and static for adverts placed to the left ($p < 0.01$) or to the right ($p < 0.05$) of the road. This suggests that if advertising is placed in 'all 3' positions or over the centre the road, drivers will look at the boards significantly longer than if they are on the left or right of the road. However, a video advert on the left or right of the road will be looked at for significantly longer than if a static advert is present in its place.

<u>*Summary*</u>

- Advert type was found to have a significant effect on glance duration
- Drivers looked at video adverts significantly more than static adverts when they were positioned on the left or right side of the road
- Advertising placed in 'all 3' positions or over the centre the road resulted in drivers looking at the adverts significantly longer than if they are placed at the side of the road

Percentage time looking at adverts

Figure 3.19 shows the mean percentage of time that participants spent looking at an advert on approach for static and video adverts compared across the factor of advert position.

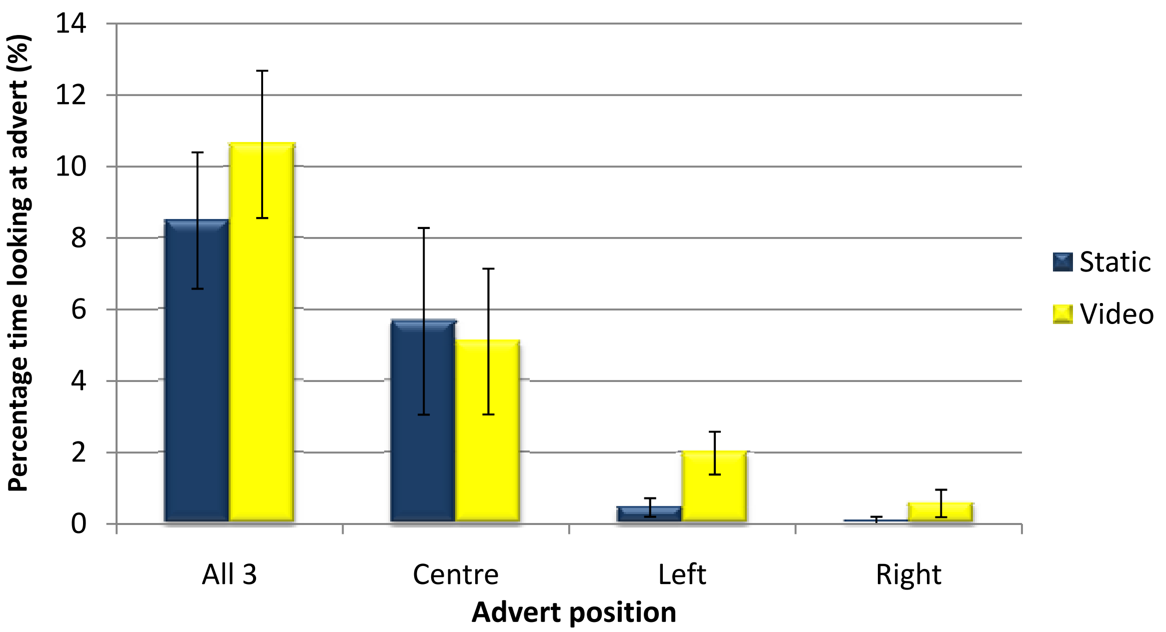

Figure 3.19: Mean percentage of time spent looking at static and video adverts across advert position type

Statistical tests performed on the data in Figure 3.19 indicated a significant main effect of advert position ($F_{(3,210)} = 32.70$, $p < 0.001$). This suggests that advert position has a strong influence on advert viewing time on approach to an advert. The contrast analysis performed indicated that each position differed significantly from all others on this measure ($p < 0.01$).

Although there was no main effect of advert type reported by the ANOVA, the planned contrast tests revealed that there was a significant difference between video and static adverts for the 'all 3' ($p < 0.01$), left ($p < 0.005$) and right ($p < 0.05$) positions, indicating that video adverts tended to attract more attention when placed in most positions.

<u>*Summary*</u>

- Advert position had a significant effect on the proportion of time a driver spent looking at an advert when approaching a position

- There was a significant difference between video and static adverts for the 'all 3', left and right positions
- Video adverts attract more attention when placed in three of the four positions

3.3.4.2 Simulator measures

SDLP

Figure 3.20 shows the mean values for the standard deviation of lateral lane position on approach to static and video adverts compared across the factor of advert position.

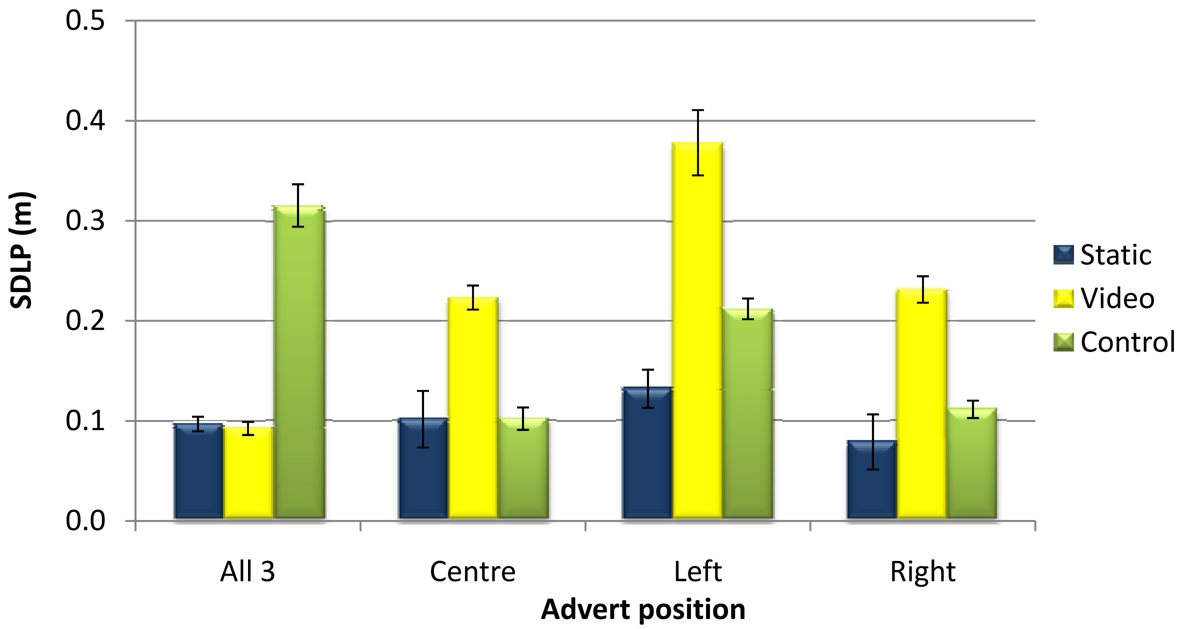

Figure 3.20: Mean SDLP on approach to static and video adverts across advert position type

Figure 3.20 shows there is little difference in SDLP for static adverts across advert positions. The repeated measures ANOVA performed on this data revealed that there was a significant main effect of advert position ($F_{(6,180)} = 46.07$, $p < 0.001$), indicating that advert position affects SDLP. There were surprisingly high SDLP values recorded for the all 3 position under control conditions. It is possible that result is an artefact of drivers choosing to cut corners (whilst remaining within lane boundaries) when no adverts were present, resulting in deviation from the centre of the lane, thereby producing higher SDLP. Planned contrasts indicated a significantly higher SDLP between the video advert and static adverts or control conditions when advertising is placed in the centre, left and right position ($p < 0.001$).

Summary

- Advert type and position were found to affect a driver's ability to maintain a consistent lane position
- SDLP was significantly increased in drivers approaching video adverts; this was when compared to both static adverts and control data for three of the four positions
- The greatest affect of video adverts on SDLP was seen in the left position

Mean speed

Figure 3.21 shows the mean speed values observed on approach to static and video adverts compared across the factor of advert position.

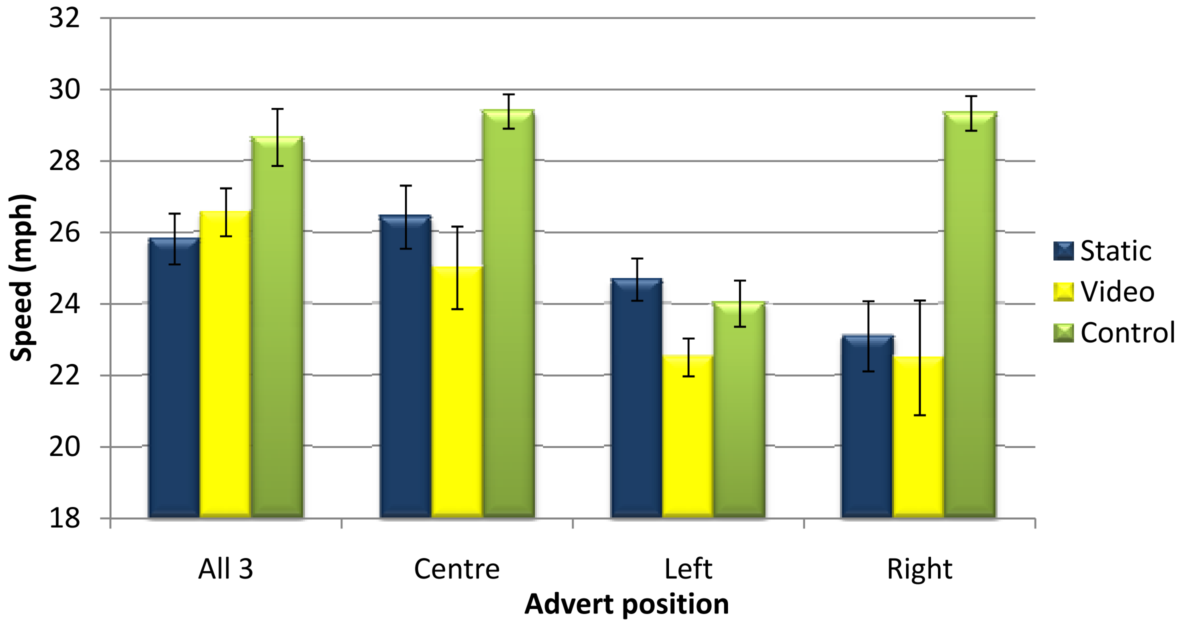

Figure 3.21: Mean speed on approach to static and video adverts across advert position type

The repeated measures ANOVA performed on data collected for mean speed during the trial shows a significant main effect of advert type ($F_{(2,120)} = 39.35$, $p < 0.001$) and advert position ($F_{(3,180)} = 30.21$, $p < 0.001$) and a significant interaction between the two ($F_{(6,360)} = 8.63$, $p < 0.001$). This again highlights that advert type and position affects measures of driving control.

Figure 3.21 indicates that for advert position, drivers tended to maintain higher mean speeds if adverts were not present and that drivers tended to adopt lower speeds when passing video adverts as compared to static adverts. Planned contrasts indicated that there was a significant difference between the control group and both advert groups in the all 3 condition, centre and right conditions ($p < 0.001$ in all cases). Static adverts and control data did not differ for the left position but there was a significant difference between mean speeds for control data against video adverts ($p < 0.05$).

<u>*Summary*</u>

- Advert type and position affected speed choice on approach to adverts
- Mean speed was always significantly lower with video adverts as compared to control data
- This suggests that drivers were attempting to mitigate perceived risk (caused by lack of attention to the driving situation) by lowering speed
- It may also mean that they slowed to view the adverts

Maximum speed

Figure 3.22 shows the maximum speed values observed on approach to static and video adverts compared across the factor of advert position.

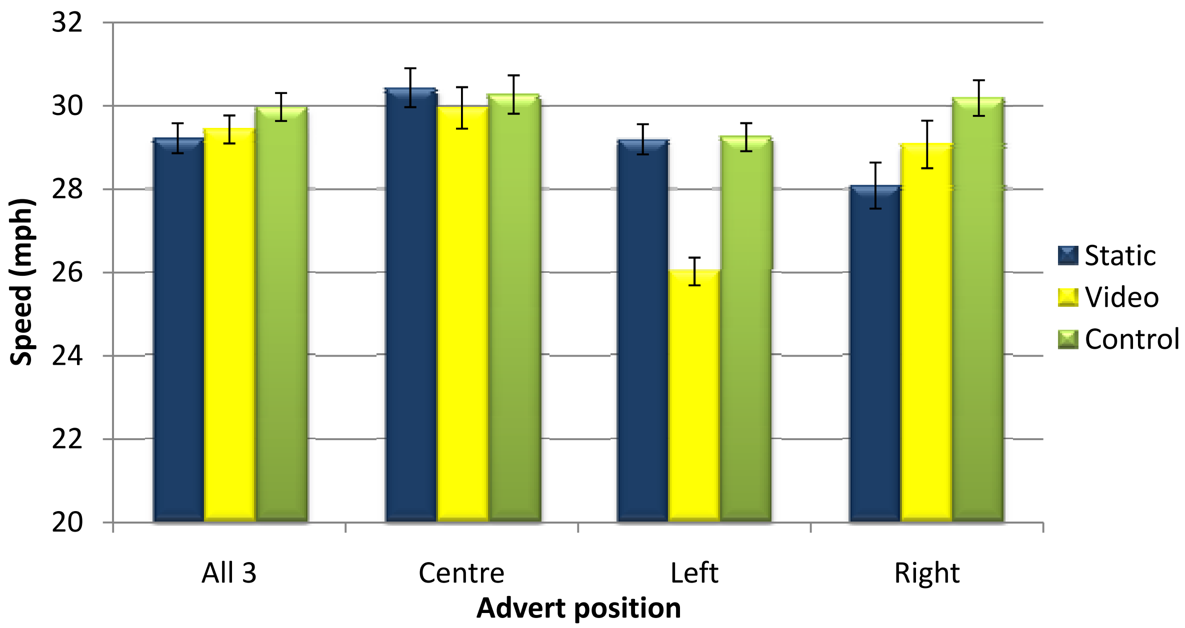

Figure 3.22: Mean of maximum speed values observed on approach to static and video adverts across advert position type

A significant main effect of advert type ($F_{(2,120)} = 27.31$, $p < 0.001$) and advert position ($F_{(3,180)} = 30.21$, $p < 0.001$) was found. The ANOVA also indicated there was a significant interaction effect between advert type and advert position ($F_{(6,360)} = 17.49$, $p < 0.001$). This result indicates a similar pattern to that seen for mean speed.

Figure 3.22 shows drivers in the advert conditions tended to achieve a lower maximum speed on approach to adverts than drivers in comparable control regions. This was supported by the results of the planned contrasts conducted as part of the ANOVA, which indicated there were significant differences between the control data group and both advertising groups when adverts were placed in all 3 positions ($p < 0.05$), and when advertising was placed on the left and right hand side of the road ($p < 0.001$). Figure 3.22 suggests that the impact of video adverts on maximum speed appears particularly pronounced when adverts are placed to the left of the road.

Summary

- Advert type and affected maximum speed achieved on approach to adverts
- When approaching adverts in the left position, video adverts resulted in a significantly lower maximum speed when compared to static and control data values
- Lower maximum speeds suggest that drivers may have been attempting to mitigate perceived risk (caused by lack of attention to the driving situation) by lowering speed
- This may also suggest that drivers slowed to view the adverts – particularly video adverts presented to the left of the road

Standard deviation of speed

Figure 3.23 shows the mean of the standard deviation of speed values observed on approach to static and video adverts compared across the factor of advert position.

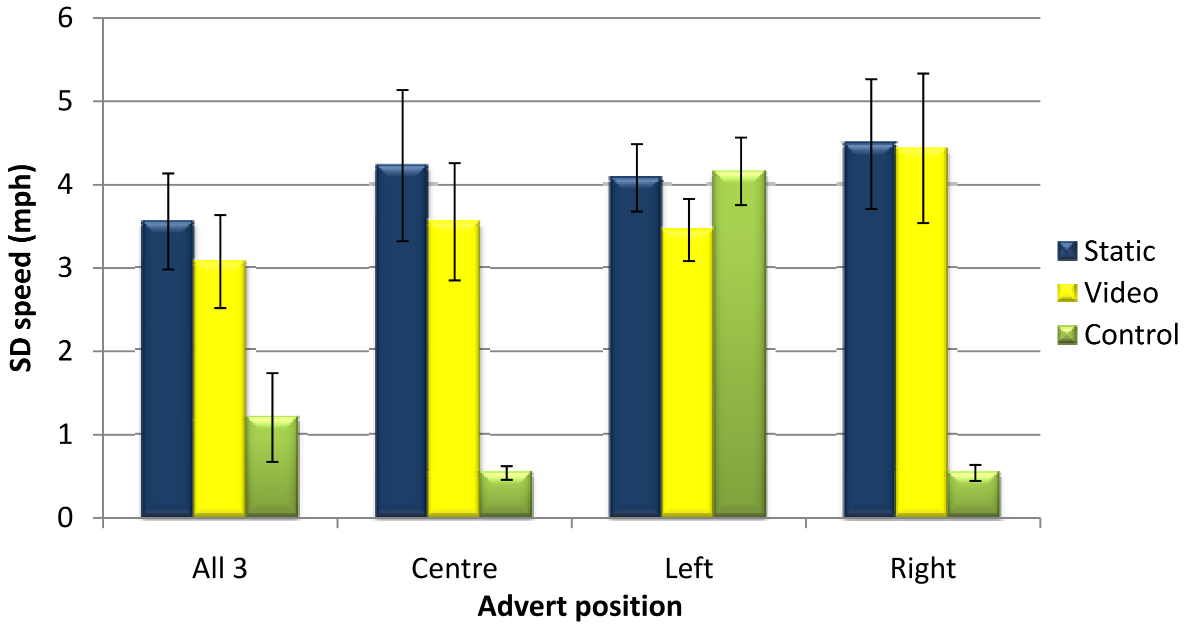

Figure 3.23: Mean of the standard deviation of speed values observed on approach to static and video adverts across advert position type

Examining standard deviation of speed, there was a significant main effect of advert type ($F_{(2,120)} = 28.69$, $p < 0.001$). Results also showed a significant main effect of advert position ($F_{(3,180)} = 6.11$, $p < 0.001$) and an interaction effect between the advert type used and advert position ($F_{(6,360)} = 7.63$, $p < 0.001$). The results indicate that a drivers' ability to maintain a smooth speed control is affected by the presence of adverts.

Figure 3.23 shows that drivers approaching adverts tended to show more speed variation than in the control condition. When examined further, the analysis indicated that in the 'all 3', centre and right conditions drivers had a significantly higher standard deviation in speed when adverts were present ($p < 0.001$). No significant differences were found when comparing control data to that for adverts placed to the right of the road ($p > 0.05$). The results clearly indicate that in three of the four positions, the presence of adverts has an effect on speed variation. In all four positions, speed variation was higher with static adverts than with video adverts.

<u>*Summary*</u>

- Advert type and position affect a driver's ability to maintain a consistent speed
- Results indicate that speed variability was significantly higher when adverts were present in the all 3, centre and right placement conditions
- In three of the four positions, the presence of adverts has an effect on a drivers' ability to maintain a consistent speed
- Speed variation tended to be slightly higher with static rather than video adverts

Maximum deceleration rate

Figure 3.24 shows the mean of the maximum brake position values observed on approach to static and video adverts compared across the factor of advert position.

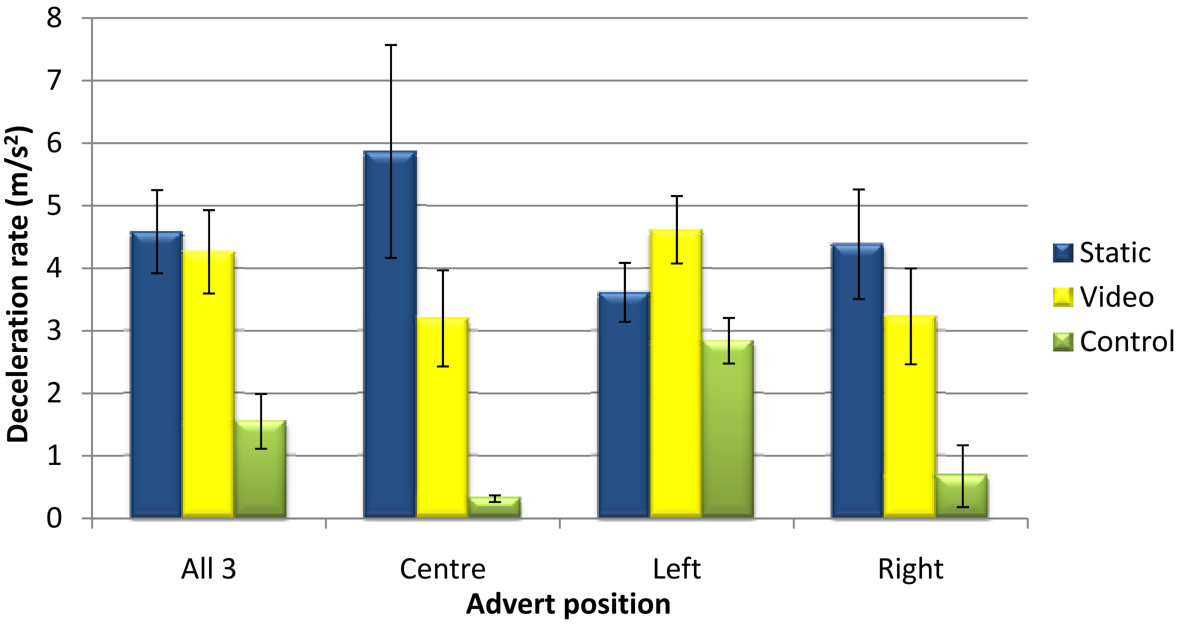

Figure 3.24: Maximum deceleration rate on approach to static and video adverts vs. control data across advert position

The ANOVA performed on data for maximum deceleration rate showed there was a main effect of advert type ($F_{(2,120)}$ = 26.81, p < 0.001), and an interaction between advert type and advert position ($F_{(6,360)}$ = 4.38, p < 0.001). These findings indicate that the advert type being approached by a driver has a significant effect on maximum deceleration in the event the driver is required to brake and that this is influenced by the particular advert position.

When examining the data in more detail, Figure 3.24 clearly shows that for each position, control driving behaviour was characterised by significantly less deceleration. This was confirmed by a planned contrast analysis of the data, which indicated that in each position the difference in braking rate was significantly different from advert conditions (p < 0.001).

Summary

- Advert type and advert position affect deceleration rate
- Drivers approaching adverts showed a higher deceleration rate than in the control condition in all four advert positions
- When drivers approached adverting placed on the left side of the road their maximum deceleration rate was significantly higher for video adverts
- When advertising was placed over the centre of the road, or to the right side, drivers passing static adverts chose to slow their vehicle significantly quicker than any other group

3.3.5 *Perception of distraction/safety*

Following the simulator trials, participants were asked to complete a short questionnaire that was designed to examine how they felt about roadside adverts. The questions asked were intended to gauge opinion as to how distracting or safe they felt particular types of adverts were, rated on a scale from 0-10 (see Appendix B).

3.3.5.1 Distraction by position

Figure 3.25 shows how participants rated the level of distraction caused by adverts placed at each of the four locations used in the study (a score of 0 represented "Not at all distracted"; a score of 10 represented "highly distracted").

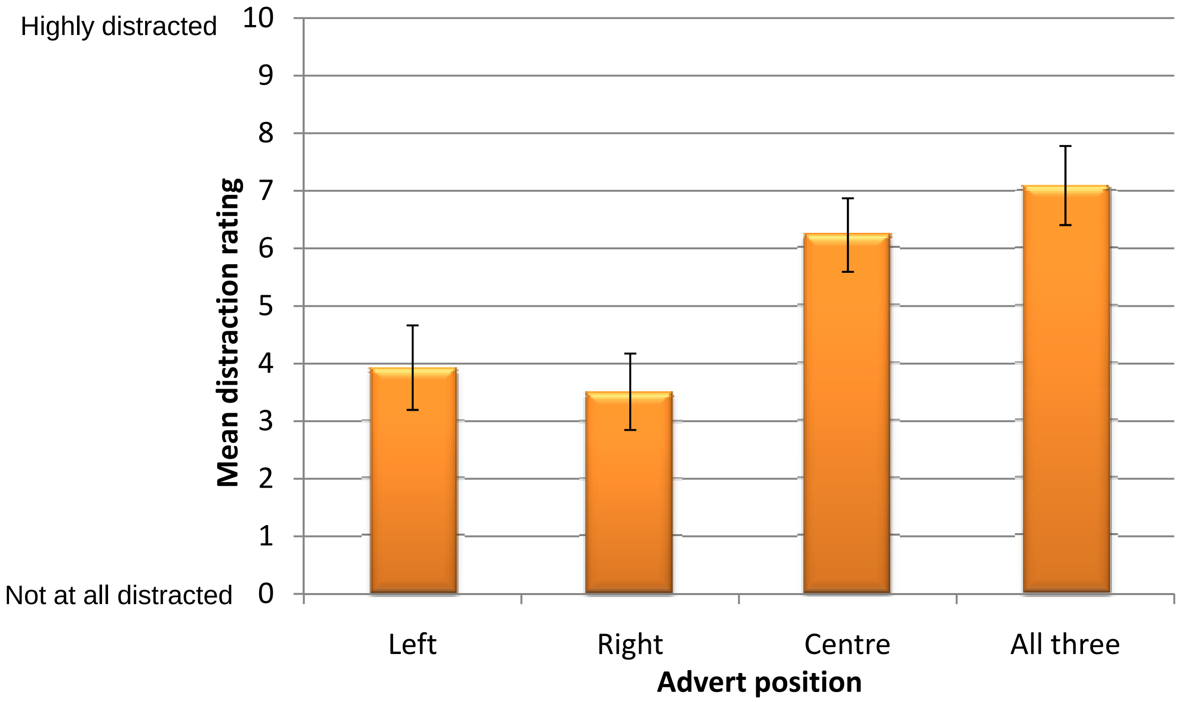

Figure 3.25: Mean subjective ratings of distraction across advert position

Independent samples t-tests were conducted to compare the level of distraction caused and demonstrated that adverts placed at the left or right did not differ in their perceived level of distraction (p = 0.41). Similarly, the difference in mean distraction rating given to adverts place above the road or at all three positions only neared significance (p = 0.076). All other comparisons between positions were highly significant ($p < 0.001$ in each case). These results are somewhat at odds with the driving and visual behaviour comparisons which tended to show that adverts to the left were more distracting than those to the right.

3.3.5.2 Distraction by presentation type (video vs. static)

Figure 3.26 shows how participants rated the level of distraction caused by static or video adverts (a score of 0 represented "Not at all distracted"; a score of 10 represented "highly distracted").

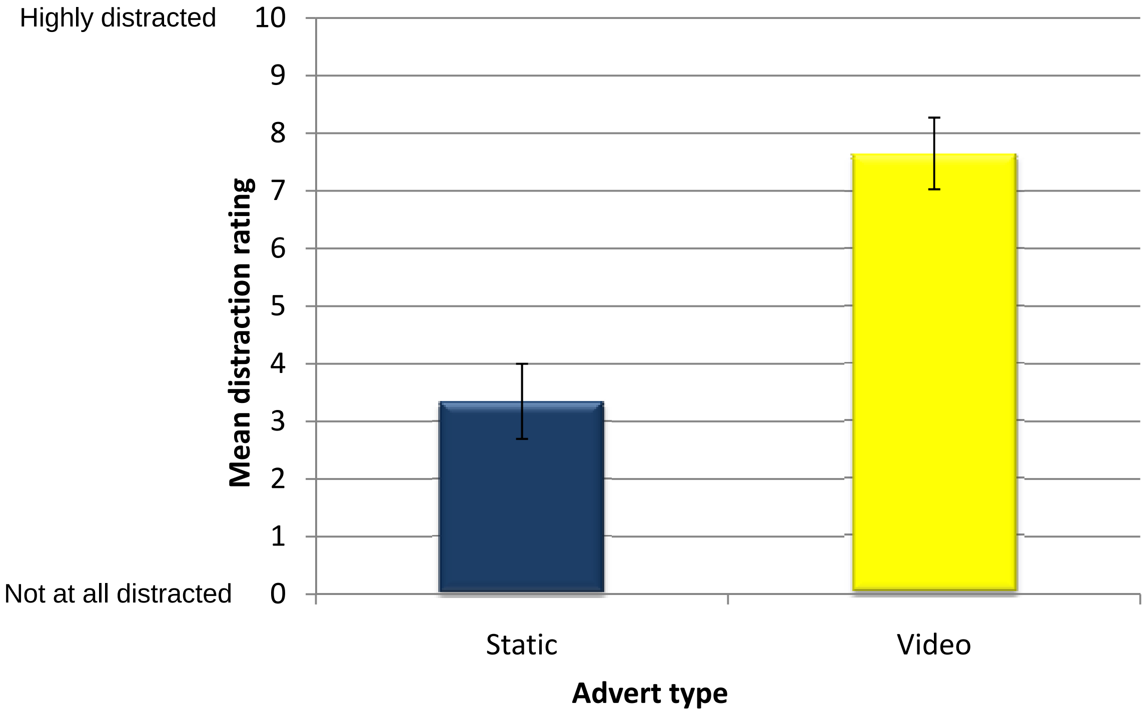

Figure 3.26: Mean subjective rating of distraction caused by static or video adverts

Figure 3.26 shows that participants clearly believe that video adverts are more distracting than static billboards, supported by a highly significant t-test result ($p < 0.001$)

3.3.5.3 *Safety by advert type*

Figure 3.27 shows participants' mean rating of how safe they felt the use of static/video adverts is (a score of 0 represented "Very unsafe"; a score of 10 represented "Very safe").

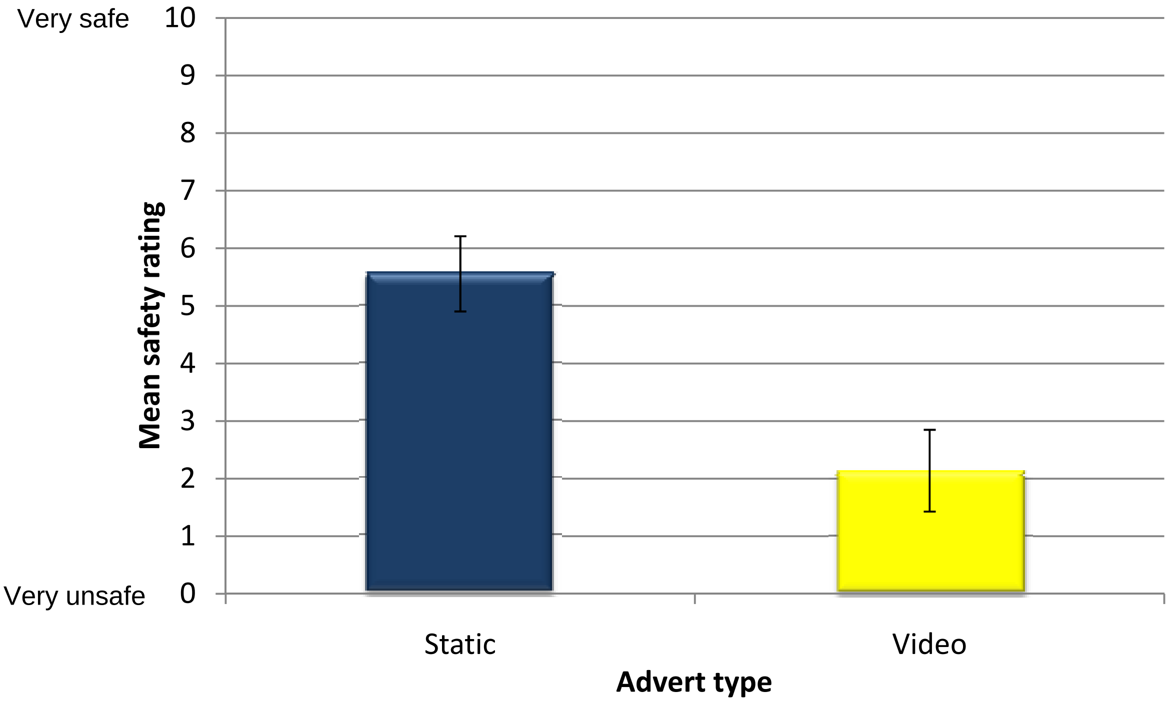

Figure 3.27: Mean safety rating given to static and video adverts (error bars show 95% confidence intervals)

Again, there is a highly significant ($p < 0.001$) difference between ratings for the static and video adverts, with video adverts being rated as very unsafe.

Participants were also asked to provide rating from 0 to 10 as to whether they felt video adverts would make safety "much worse" (0); "no change" (5); or "much better" (10). The mean score was 2.09 (SD = 1.54), suggesting that, having experienced driving in the presence of video adverts, participants felt safety would be negatively affected.

3.3.5.4 *Comments*

Appendix C shows a list of the free response comments provided by participants in response to the question: "Please give us any general comments you have about STATIC and VIDEO advertising billboards". It can be seen that there are several comments alluding to increased distraction caused by video adverts, supporting the overall trend seen in the subjective results e.g.:

"Static you tend to just glance as where as the full motion you tend to watch for a lot longer, feels like you are made to look at it."

"The static adverts didn't distract me at all but the full motion videos definitely caught my attention."

"I found the full motion video advertising billboards very distracting and these were losing my concentration on the road. Static billboards are not very distracting as nothing is moving in them."

4 Discussion

4.1 Review of study aims

The purpose of this study was to quantify the distracting effects of billboard advertising on drivers when placed near a road in representative configurations similar to those found in the London area and as shown in ARC Outdoor Media Surveys (2005). Representative advertising boards were placed in a highly realistic 'virtual' London environment, displaying video and static advertising images. Participants in the study then drove through this environment and performance was assessed on the approach to such advert boards. As part of this study, advert position has been examined to evaluate which positions create the greatest distraction for a driver. This section of the report provides independent assessment of the findings of this study and makes a number of recommendations for further research. It also provides information and steps that could be taken to limit the distracting affects of advertising. To date, highway authorities and research groups have presented limited evidence demonstrating the distracting nature of advertising hoardings.

From the results gained from this study, the effects of each advert type relative to a situation where no advertising being present can be seen. The findings indicated there are a number of detrimental effects on driving performance when video adverts are present; when comparing performance to both static adverts and when no adverts are present. These effects are wide ranging and can influence four main areas of driving control (Figure 4.1). It appears that behaviour when adverts are present differs from that when it is absent, with video advertising causing a more pronounced effect on behaviour than static adverts. Speed control, braking and the variability of these vehicle control measures are greatly affected by adverts. Drivers also appear to be less able to maintain a consistent position within the lane in which they are travelling. There are also identifiable changes in driver performance relating to advert position. To a lesser extent, the amount of time a person can see the advertisements on the board also has been shown to influence driver distraction. The following sections discuss these findings in more depth.

4.2 The effect of advert type on driver performance

Statistical tests on data collected in trials (Section 3.3) indicated video adverts are significantly more distracting than the more traditional static adverts. There are also differences in driver visual behaviour included drivers making significantly more glances to video adverts and spending significantly longer with their eyes away from the road ahead, than when static adverts were similarly placed. This result suggests that the presence of moving images on an advertising board draws a driver's attention towards the advert and away from the driving task and road. This finding is of little surprise; the human visual system has evolved to detect changes in the surroundings, thereby giving moving images an immediate advantage. That drivers' visual attention was drawn away from the road to view video adverts more frequently and for longer is of concern in an urban area such as London with a relatively high density of vulnerable road users. A driver's visual attention to the driving task is vital to minimise collision risk.

It has also been possible to examine the effect different types of advertising have on aspects of driving control. During the course of analysis, it became clear there were a number of significant effects of advert type on a driver's ability to control speed. The first result of interest related to the average speed that a driver maintained during the course of passing advertising boards. Drivers approaching static adverts maintained a significantly higher speed during the 100m prior to an advert board, when compared to drivers passing video adverts. Coupled together with the earlier finding that video advertising boards were looked at significantly more than static boards, it can be suggested that drivers were in fact slowing down to look at the video advertising.

Initially this may appear an acceptable compromise, if a driver was to look at something unrelated to the task of driving, slowing down reduces the risk of causing a collision. However, while a reduction in maximum and average speed may reduce perceived collision risk, it does not produce a commensurate reduction in the actual collision risk. This is shown by the heavier braking and greater variation in lateral lane position observed in the presence of the video adverts. In terms of braking, the significant increase in deceleration rate suggests that drivers were distracted and braked later; requiring more force and urgency. This more violent braking could increase the chance of losing control of the vehicle when trying to avoid an object, vehicle or pedestrian.

This finding suggests that there are four key areas where driver distraction can affect the safe operation of the car. Figure 4.1 highlights the four areas in which there is evidence of a change in driver behaviour. These changes are fundamental to the safe control of the vehicle. The result that distraction caused by video adverts has such a strong effect on driver performance is of concern. There were three instances of simulated pedestrians being struck during the course of the trial, as part of the advertisement reaction tests; all three were during the approach to a video advert. This was a collision rate of 1/644 per advertising pass; in contrast there were no collisions while approaching a static advertising board.

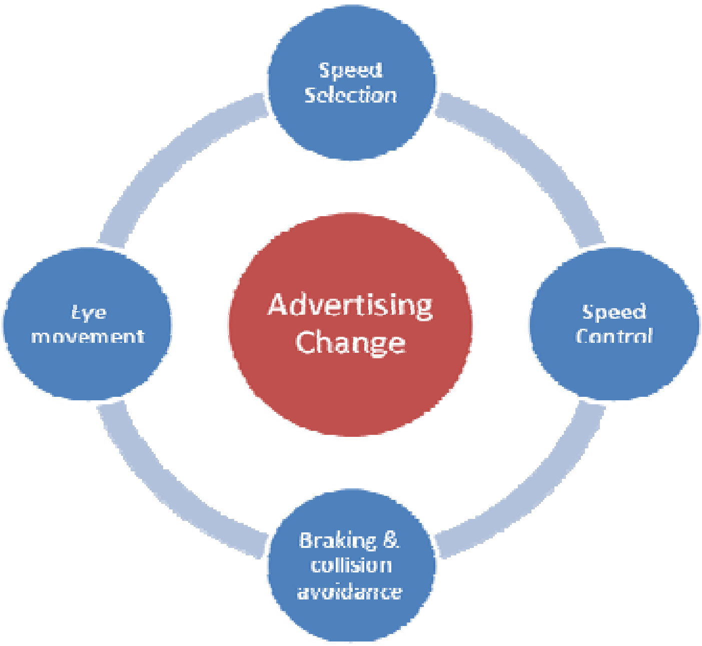

Figure 4.1: The identifiable changes in driver behaviour when distracted by video advertising

4.3 The effect of advert exposure time on driver performance

Advert exposure time was examined by manipulating the position of structures ahead of adverts to control the duration over which the advert was visible. Results suggest that advert exposure time has a significant effect on driver behaviour and the effect is greatest on approach to a video advert. Examining glance duration, there was a significant difference between video and static advertising in both the medium and short exposure duration conditions. There was no significant difference between video and static conditions when a long duration advertising board was being approached. This shows that there is a greater distracting effect of video advertising when approaching a medium or short exposure advert. A driver may be able to scan a video advert at a long distance with less disruption. The results revealed significant differences in all three duration conditions, with drivers viewing video adverts for a significantly longer percentage of time than with static adverts. The results show that a video advert of medium duration exposure was the most distracting condition.

If aspects of a driver's visual performance have changed, driving control is likely to be affected and this was found to be the case. When examining variation in lateral lane position, static advertising caused no significant increase at any duration of advert exposure. In contrast, there was significantly increased variation in lateral lane position for the video group for medium and short exposure durations and a trend of increasing lateral variation as advertising duration decreased. This suggests that if there is less time for drivers to look at the video advertising board, their choice to look at the board may have led to a lack of lane position control. In a highly populated area and complex traffic environment such as London, good lane discipline is vital in avoiding collisions with other road users.

It is also clear from the results that elements of speed selection were affected, depending on both the type of advert and the duration of exposure. Results indicated a significant difference between the average speed of the video and static group in the long and medium duration conditions, with a tendency for higher speeds with static adverts. From Figure 3.13, it is clear that the difference in speed is greatest in the medium duration exposure condition. This result fits with the eye movement data to suggest that the driver is slowing down to view the advertising. This is only significant in the case of video advertising and is reflected in a decreased maximum speed in both long and medium exposure time conditions. This indicates that drivers passing static advertising maintained a significantly higher average and maximum speed compared to passing video advertising. As the approach to both medium and long adverts give the drivers the greatest chance of distraction (supported by eye movement data), it has been suggested that the reduction in speed is due a driver knowingly looking at the advert and slowing to reduce their perceived risk. However, when examining the type of advertising and the effect on car control, it was found that this also resulted in poor braking performance, thus mitigating the benefit of any reduction in speed.

Results indicated that while there were no significant differences between the deceleration rates for video and static groups when approaching a long duration advertising board, a significant difference was identified between video and static groups for medium exposure duration adverts with the mean deceleration rate for video adverts being significantly greater. This higher braking may either be due to drivers slowing to view the adverts or slowing to mitigate perceived risk whilst they view the adverts.

When examining the duration of advertising visibility it is clear that the condition causing the least detrimental effect on behaviour was the long exposure condition. In the study, this meant that the advertising was visible for around six seconds, thereby reducing the constraint on drivers to look at the advert for a continuous period. However, it appears that at each exposure duration condition, drivers were more distracted by video adverts than static advertising. These findings provide further evidence that video adverts significantly distract a driver beyond that observed with static adverts.

4.4 The effect of advert position on driver performance

A further aim of this study was to examine how advert position influences driver distraction. The results of this section revealed a number of different effects on driving performance based on advert position and type. When examining the pattern of results, two key patterns emerge. Firstly, the 'all 3' advert position was the most visually distracting condition, followed by the centre, left, and right positions. Secondly, superimposed on this pattern was a tendency for video adverts to attract more attention than static adverts at all positions. This is shown most clearly by Figure 3.17.

As previously discussed, the foundation of any distraction effect can be judged by the influence the advert has on a driver's eye movements. However, such advertising would be further highlighted as a danger if it then provokes a detrimental change in the driver's control behaviour. The analysis conducted does indicate that driver's vehicle control performance was affected by the type of advertising that they encountered.

A clear example of changes in behaviour based on advert position is shown in Figure 3.20 in which it can be seen that video adverts in the centre and right positions cause increases in variation in lateral lane position but video adverts positioned to the left cause an even more severe impairment. This supports the eye movement data; the greatest difference in mean glance duration between video and static advertising occurs when the advertisement is placed on the left side of the road.

As has been reported previously, mean speeds were typically lower when adverts were present. Comparing speed variability under control conditions with that observed for static and video adverts showed that drivers were less able to maintain a consistent speed when adverts were present for the 'all 3', centre and right advert positions. Surprisingly (given other results), speed variation tended to be slightly higher for static rather than video adverts.

4.5 Subjective opinions

Participants were asked to provide their views on their experience of driving through a simulated route with static and video adverts present. Their opinions were coherent with the objective measures provided by the eye tracker and driving simulator. Participants rate the 'all 3' advert position as most distracting, rating the centre, left, and right adverts as successively less distracting. This is consistent with the measures of visual distraction seen for the factor of advert position. Participants also gave a clear impression that they found video adverts more distracting than static adverts. Finally, were asked how safe they felt static and video adverts were. Participants gave a neutral response for static adverts and a clear negative response for video adverts suggesting they felt that road safety could be jeopardised by the introduction of video adverts. The novelty effect of seeing video adverts in the driving situation for the first time may be a factor in these results. However, it should be remembered if video adverts are to become more widespread, many drivers will have a first time viewing of a video advert and they are likely to be significantly more distracted on this occasion than in subsequent viewings.

4.6 Comparison to other driving impairments

An increase in variation in lateral lane position is not in itself necessarily the clearest indicator of driving impairment. However, when the changes can be compared with other types of driving impairment, a better understanding of the implications can be achieved. The increases in variation in lateral lane position, particularly at the short duration exposure time are consistent with a greatly increased tendency to drift into the offside lane or onto the nearside kerb, greatly increasing the risk of collision and/or injury. By comparison with other impairments tested on the simulator, cannabis has been shown to increase variation in lane position by 35% (Sexton, Tunbridge, Brook-Carter, Jackson, Wright, Stark, & Englehart, 2000) whilst trying to write and send a text message caused this measure to increase by 91% (Reed & Robbins, 2008). Consumption of alcohol to the legal limit caused some impairment to consistency of lateral lane position but failed to reach significance (Burns, Parkes, Burton, Smith & Burch, 2002). Although, the measures reported here were taken in a different driving environment and context, it is apparent that the impairment to performance when viewing video adverts is of a similar magnitude. Unlike, cannabis or alcohol, the detrimental effect of an advert is likely to be short-lived – limited to the time in which the driver has a clear view of the advert. However, the level of impairment that these adverts may cause drivers for each advert placed in the urban environment should be understood in this context.

4.7 Process by which advertising distraction affects driving performance

While examining the data collected in this study, it is clear there is a process at work when drivers are distracted by advertising. Examining the data, a logical process can be developed to depict this process. Figure 4.2 presents a process diagram which ties together the results found.

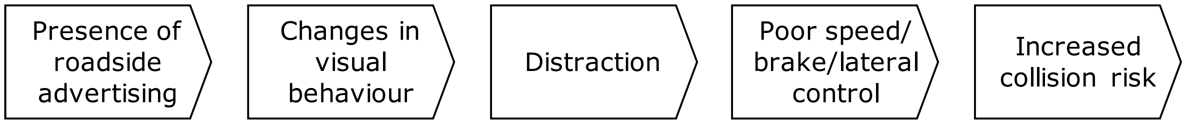

Figure 4.2: Process that governs driver distraction by advertising

The initial stages of distraction, by definition, require that the driver’s attention to be disrupted from the primary task (i.e. driving). It is possible to define a measure of distraction, as driving is a visuomotor task. Driving requires the driver to direct their gaze at the road ahead, and the increase in gaze towards advertising indicates eye movements can be used as a measure of distraction. In all cases, regardless of position or duration of advertising, the results showed that visual behaviour was significantly affected by the presence of adverts and that this appeared more pronounced for video adverts.

Any distraction from the main task has implications for the ability of the driver to control the vehicle in a safe manner. Estimates of distractions caused by irrelevant objects and features (e.g., pedestrians, parked cars and other objects near the road) near the roadway occur between 20% and 50% of the time (Green, 2002; Hughes and Cole, 1986; Land and Lee, 1994). This is compounded by the increased distraction caused by the presence of adverts, particularly when the advert contains moving images.

Wallace (2003) reviewed driver’s responses to adverts. This research suggested that a driver can be ‘overloaded’ with irrelevant information at critical times during a route. This study would provide support for this suggestion of an increased workload. Increased visual workload, in the form of watching video adverts, will result in a “secondary task” being formed. Performing a secondary task while driving (primary task), has been shown by previous research to affect car control performance. Studies have linked mobile phone conversations, texting and other distracting activities to reduced driver safety. In essence, video adverts create an additional load for a driver and as found in this study, performance in the driving task will be reduced. It is not possible to be certain how many of collisions are caused by static adverts. However, the results of this study suggest that if video adverts were to be used in an urban area there could be an increase in collisions due to driver distraction.

A driver’s ability to control a vehicle relies on their attention to the driving task. As a driver is distracted by advertising, it appears their ability to select an appropriate speed and control that speed is reduced. A consistent speed helps to maintain a high traffic flow, minimising congestion. It also helps reduce the risk of sudden braking or the need for other drivers to correct their speed. There are also implications for the increased braking severity seen when approaching video advertising. There is an increased risk of losing control of a vehicle under heavy braking and an increased risk of rear-end shunts. These changes in behaviour all appear to stem from the initial change in visual behaviour, and are in fact the driver’s attempt to manage the risk associated with looking at an advert a greater duration.

5 Conclusions

The purpose of this study was to determine the distracting nature of advertising placed near roads of a similar type to those found in the London area; specifically two types, video and static advertising. This study has also aimed to identify the relative effect of different advert positions based on real advert configurations used in London. Although simulation does not provide an exact replica of the situation observed with real driving, there are significant methodological, safety and price constraints that make studies of real world behaviour in relation to distraction by billboard advertising very difficult. In using the driving simulator at TRL, every effort was taken to ensure that this simulator study represented the London driving scene as accurately as possible. In addition, a number of experimental factors could be manipulated in a manner that is not possible in the real world, large volumes of accurate data could be collected, and participants were in complete safety at all times.

Through analysis of the experimental data, this study has provided useful insights into the differential effects of roadside billboard advertising on driver behaviour. The report has found significant effects on both drivers' visual behaviour and driving performance when static and video adverts are present and that the video adverts seem more potent distractors than similarly placed static adverts. The results support and extend other studies of driver distraction by advertising (Crundall *et al.*, 2006; Young and Mahfound, 2007). This report constitutes direct research into the area of driver distraction and has indicated that while affordable plasma and LED screens showing video advertising may be available, caution should be exercised in the use of this technology. While it is clear there are some effects of position and duration of exposure, the main finding is that video adverts provide a greater distraction than that currently caused by drivers approaching equivalent static adverts.

5.1 Further work

Numerous issues have been identified within this study that merit further investigation. Some examples are described below:

- **Review any further plans to use video advertising within the Greater London area**
  - This study suggests that the use of video based adverts result in a significant reduction in driving performance. This should be avoided in a dense urban environment where a driver's attention is vital to avoiding collisions. There are alternatives to the video advertising boards, in the form of traditional poster boards. They provide less disruption to driver attention, and therefore less disruption to their driving skills.
- **Conduct a review of collisions around advertising within the Greater London area**
  - In addition to the findings of this report, we would recommend conducting a review of collisions that have occurred in London, around advertising. The aim of this review would be to identify any collision clusters, and also to identify any common factors that increase the risk of a collision. The research would provide planners with further evidence of areas that should not be populated with any further advertising, and may identify areas where advertising should be reduced. It may also provide a "risk checklist" that could be used to assess whether a planning application is appropriate; ensuring that advertising is not placed in an area where it may cause an unacceptable distraction for passing traffic.
- **Examine the feasibility of conducting an audit of current advertising**
  - The results of this study have highlighted the need to consider the placement and visibility duration of advertising boards. There is likely to be an increase in driver workload depending on the type of area a driver is travelling through, making the sites where advertising may be placed (or currently placed) key to driver safety. If the desire to implement roadside video advertising gains impetus, it would be advisable to identify areas where this type of advertising is not appropriate for use. These areas would be identified by certain criteria that would increase the workload on a driver.
- **Examine the effect of variation in advert density on driver performance**
  - This study used a relatively low density of static and video adverts. Consequently, there may have been a something of an ongoing novelty effect of each advertising board. It may be of interest to determine if this is reduced when a high density of adverts is used to replicate the situation if/when video advertising is more commonplace.
- **Examine the effect of advert size / content**
  - A key variable that was controlled in this study was the size of each advert. A new study could investigate the relative distraction effects of smaller/larger advertising boards.
  - Similarly, great effort was made to ensure the set of static and video adverts used were homogenously distracting to a wide range of drivers. It would be of interest to study the effect of very distracting adverts (targeted to a specific demographic) on driver behaviour relative to less distracting items.
- **Real world validation**
  - Whilst every effort was made to ensure that the simulator study was as lifelike as possible, it is clear that simulator driving is representative of real driving performance but not an exact replica. Confirmation of the validity of the

simulator results could be achieved by running validation studies on a test track or at a suitable on-road location.

Acknowledgements

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References

Ady, R. (1967). An investigation of the relationship between illuminated advertisement signs and expressway accident. *Traffic Safety Research*, **3**, 9-11.

ARC Outdoor Media Surveys (2005). Produced for TfL, London.

Burns, P.C. Parkes, A., Burton, S., Smith, R.K., & Burch, D. (2002). *How dangerous is driving with a mobile phone? Benchmarking the impairment to alcohol*. TRL Report RL547, Crowthorne, United Kingdom: Transport Research Laboratory.

Crundall, D., Van Loon, E. & Underwood, G. (2006). Attraction and distraction of attention with roadside advertisements. *Accident Analysis and Prevention*, **38**, 671-677.

Green, P. (2002). *Where do drivers look while driving (and how long for)?* In: Dewar, R.E. & Olson, P.L. (Eds.), Human Factors in Traffic Safety. Lawyer and Judges Publishing, Tucson, AZ, pp. 77-110.

Hughes, P.K. & Cole, B.L. (1986). What attracts attention when driving? *Ergonomics*, **29**, 311-391.

Land, M.F. & Lee, D.N. (1994). Where we look when we steer. *Nature*, **369**, 742-744.

Reed, N. & Robbins, R. (2008). *The effect of text messaging on driver behaviour: a simulator study*. TRL Published Report 367, Crowthorne, England: Transport Research Laboratory.

Sexton, B.F., Tunbridge, R.J., Brook-Carter, N., Jackson, P.G., Wright, K., Stark, M.M., & Englehart, K. (2000). *The Influence of Cannabis on Driving.* TRL Report 477, Crowthorne, England: Transport Research Laboratory.

TfL (2007). *Casualties in Greater London during 2007*. Surface Transport Fact Sheet - London Road Safety Unit, London, England: Transport for London.

Wallace, B. (2003). Driver distraction by advertising: genuine risk or urban myth? *Municipal Engineering*, **156**, 185-190.

Young, M.S. & Mahfound, J.M. (2007). *Driven to Distraction: Determining the effects of Roadside Advertising on Driver Attention*. Ergonomics Research Group Report, Uxbridge, UK: Brunel University.

Appendix A TRL CarSim

A.1 TRL Driving Simulator

TRL has successfully operated a driving simulator for more than 15 years and in that time the simulator has seen a number of different incarnations to keep pace with improvements in vehicle, projection, computing, and simulation technologies and as such is one of the most advanced simulators in the UK. The latest iteration uses a Honda Civic family hatchback (see Figure A.1). Its engine and major mechanical systems have been replaced by a sophisticated electric motion system that drives rams attached to the axles underneath each wheel. These impart limited motion in three axes (heave, pitch, and roll) and provide the driver with an impression of the acceleration forces and vibrations that would be experienced when driving a real vehicle. This significantly enhances the realism with which drivers approach the driving task and reduces the incidence of simulator sickness (a condition with symptoms similar to those of motion sickness) among participants. All control interfaces have a realistic feel and the manual gearbox can be used in the normal manner (automatic gears can be simulated).

Figure A.1 TRL driving simulator, CarSim

Surrounding the simulator vehicle are large display screens onto which are projected the graphic images that represent the external visual environment to the driver. The level of environmental detail includes photo-realistic images of buildings, vehicles, signing, and markings, with terrain accurate to the camber and texture of the road surface. We have also recently added the capability to simulate night-time driving scenarios. The driving environment is projected at a resolution of 1280×1024 onto three forward screens to give the driver a 210º horizontal forward field of view. The presence of the two flat side screens adjacent to the driver gives a very strong impression of other vehicles travelling alongside of the vehicle. A rear screen provides a 60º rearward field of view, thus enabling normal use of all mirrors.

Surveillance video cameras are mounted in the car and participants can be recorded during their drive. There is also an intercom facility for communication between the vehicle and the control room. An in-car colour LCD display can also be used to give instructions or provide other task-related information.

Figure A.2 TRL CarSim: Control Room

More than one hundred autonomous traffic vehicles can be programmed to participate in the simulation. TRL has a library of different vehicle types to choose from including cars, trucks, buses, emergency vehicles, bicycles, and pedestrians. Each obeys specific driving rules to behave in a normal manner with respect to other traffic vehicles. However, these can be overridden causing them to perform specific manoeuvres e.g. emergency stop, sudden lane change etc. The autonomous vehicles also have dynamic properties of their own – they appear to pitch realistically under acceleration and braking, and vehicle graphics include body tilt and roll under braking, acceleration and turning; speed dependent rotating wheels and fully working brake, indicator, fog, and head lights. These provide additional cues to the driver and greatly enhance the realism of a scene. To generate scenarios with a heavy traffic load (> 1700 vehicles per lane per hour) we can generate a vehicle 'swarm'. The swarm function allows us to define a region around the driver where vehicles will be placed and controlled. A vehicle moving out of the visible range of the driver is replaced by a new vehicle positioned to maintain the desired traffic density. This gives the impression of very high volume of traffic while maintaining the performance of the simulator.

A stereo sound system with speakers inside and outside the vehicle generates realistic engine, road, and traffic sounds to complete the representation of the driving environment. The software used to implement the simulation is called SCANeR II and was created by OKTAL to provide a flexible and powerful simulation with a highly advanced traffic model. It is employed by more than twenty research institutes across the globe and TRL leads the user group with access to OKTAL expertise for trial set-up and integration, if required.

The dynamics of the vehicle are modelled using a validated vehicle model that is used for product development by Renault. The model interprets the driver's control inputs, relates them to the current vehicle status and computes a prediction of how a real vehicle would behave in the given circumstances. The system then responds to present to the driver its optimal representation of how this behaviour would be perceived through the visual, sound, and motion sub-systems. The vehicle dynamics are updated at 100Hz whilst the visuals are refreshed at 60Hz so that the driver perceives a seemingly continuous driving experience. Data is then recorded relating to all control inputs made by the driver, including steering, pedals, gear, indicators; vehicle parameters such as speed, RPM; and parameters to assess behaviour in relation to other vehicles such as distance and time headways. The data recording rate is fully controllable dependent upon the trial demands, up to a rate of 100Hz.

The simulator also includes a full integrated SmartEye eye–tracking system for the analysis of driver visual behaviour. This system, in addition to being able to report the driver's gaze direction, is integrated with the 3D environment presented in the simulation, such that the eye-tracker can report in the simulator data the specific element on which the participant is fixating – a specific road sign, traffic light, the road ahead, or interior items such as the instrument panel or infotainment system. This dramatically improves the accuracy and efficiency of post-trial data analysis.

Participants for trials are recruited from a dedicated database of over 1000 members of the public. This comprises drivers from a wide range of ages and backgrounds, all of whom are familiar to TRL such that participants from particular demographic bands or driving experience/ability ratings can be selected to suit the trial requirements. The simulator facilities include a medical room for taking any physiological measures and trials management staff are trained in Good Clinical Practice. There is an interview room for questionnaire completion and debriefing and an information room for conducting computer based test or training tasks. Data management procedures are well established and compliant with the Data Protection Act 1998 to ensure security, confidentiality, and integrity of all records.

Appendix B Questionnaire used in the trial

To be completed by TRL

Participant Number: ________________ Date of Trial: _____/_____/_________

Driving Simulator Study: URBAN DRIVING

SECTION A
DRIVER PROFILE

Note:

- All information on this form is confidential.
- It will be stored securely at TRL.
- No information will be used by other projects at TRL.
- No individuals will be identified.

A1. Name			
A2. What was your age at your last birthday?			
A3. Are you Male or Female? (please tick)			
Male		*Female*	
A4. How many years have you held a full driving licence?			
A5. Approximately how many miles have you driven in the last year?			
A6. What type of vehicle(s) do you drive? (tick all those that apply)			
Motorcycle			
Car			
Light Goods Vehicle			
Heavy Goods Vehicle			

SECTION B
YOUR DRIVING

(Please circle the number that you feel is most appropriate)

B1. In general, do you enjoy driving?

Completely dislike driving — *Thoroughly enjoy driving*

0	1	2	3	4	5	6	7	8	9	10

B2. On how many days do you drive in a typical week?

Never — *Every day*

0	1	2	3	4	5	6	7

B3. On average, how many days per month do you drive in an urban or built-up environment?

B4. In general, how calm do you feel when driving?

Very nervous — *Very calm*

0	1	2	3	4	5	6	7	8	9	10

B5. In general, how calm do you feel when driving in an urban environment?

Very nervous — *Very calm*

0	1	2	3	4	5	6	7	8	9	10

B1. Please tick the appropriate box that corresponds to the level of symptoms that you are experiencing **right now**.

	No 0	Slight 1	Moderate 2	Severe 3
1. General discomfort	☐	☐	☐	☐
2. Fatigue	☐	☐	☐	☐
3. Headache	☐	☐	☐	☐
4. Eyestrain	☐	☐	☐	☐
5. Difficulty focussing	☐	☐	☐	☐
6. Increased salivation	☐	☐	☐	☐
7. Sweating	☐	☐	☐	☐
8. Nausea	☐	☐	☐	☐
9. Difficulty concentrating	☐	☐	☐	☐
10. Fullness of head	☐	☐	☐	☐
11. Blurred vision	☐	☐	☐	☐
12. Dizzy (eyes open)	☐	☐	☐	☐
13. Dizzy (eyes closed)	☐	☐	☐	☐
14. Vertigo*	☐	☐	☐	☐
15. Stomach awareness**	☐	☐	☐	☐
16. Burping	☐	☐	☐	☐

* Vertigo is experienced as loss of orientation with respect to vertical upright.
** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.
*** Visual flashbacks: illusory (motion) aftereffects reminiscent of sensations when in the simulator.

SECTION C
YOUR EXPERIENCE OF DRIVE 1

(Please circle the number that you feel is most appropriate)

C1. How calm did you feel after DRIVE 1?

Very nervous										*Very calm*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

C2. Please tick the appropriate box that corresponds to the level of symptoms that you were experiencing **<u>at their worst</u>.**

	No 0	Slight 1	Moderate 2	Severe 3
1. General discomfort	☐	☐	☐	☐
2. Fatigue	☐	☐	☐	☐
3. Headache	☐	☐	☐	☐
4. Eyestrain	☐	☐	☐	☐
5. Difficulty focussing	☐	☐	☐	☐
6. Increased salivation	☐	☐	☐	☐
7. Sweating	☐	☐	☐	☐
8. Nausea	☐	☐	☐	☐
9. Difficulty concentrating	☐	☐	☐	☐
10. Fullness of head	☐	☐	☐	☐
11. Blurred vision	☐	☐	☐	☐
12. Dizzy (eyes open)	☐	☐	☐	☐
13. Dizzy (eyes closed)	☐	☐	☐	☐
14. Vertigo*	☐	☐	☐	☐
15. Stomach awareness**	☐	☐	☐	☐
16. Burping	☐	☐	☐	☐

* Vertigo is experienced as loss of orientation with respect to vertical upright.
** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.
*** Visual flashbacks: illusory (motion) aftereffects reminiscent of sensations when in the simulator.

SECTION D YOUR EXPERIENCE OF DRIVE 2										
(Please circle the number that you feel is most appropriate)										
D1. How calm did you feel after DRIVE 2?										
Very nervous										*Very calm*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

D2. Please tick the appropriate box that corresponds to the level of symptoms that you were experiencing **<u>at their worst</u>.**

	No 0	**Slight** 1	**Moderate** 2	**Severe** 3
1. General discomfort	☐	☐	☐	☐
2. Fatigue	☐	☐	☐	☐
3. Headache	☐	☐	☐	☐
4. Eyestrain	☐	☐	☐	☐
5. Difficulty focussing	☐	☐	☐	☐
6. Increased salivation	☐	☐	☐	☐
7. Sweating	☐	☐	☐	☐
8. Nausea	☐	☐	☐	☐
9. Difficulty concentrating	☐	☐	☐	☐
10. Fullness of head	☐	☐	☐	☐
11. Blurred vision	☐	☐	☐	☐
12. Dizzy (eyes open)	☐	☐	☐	☐
13. Dizzy (eyes closed)	☐	☐	☐	☐
14. Vertigo*	☐	☐	☐	☐
15. Stomach awareness**	☐	☐	☐	☐
16. Burping	☐	☐	☐	☐

* Vertigo is experienced as loss of orientation with respect to vertical upright.
** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.
*** Visual flashbacks: illusory (motion) aftereffects reminiscent of sensations when in the simulator.

SECTION E
YOUR EXPERIENCE OF DRIVE 3

(Please circle the number that you feel is most appropriate)

E1. How calm did you feel after DRIVE 3?

Very nervous										*Very calm*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

E2. Please tick the appropriate box that corresponds to the level of symptoms that you were experiencing <u>at their worst</u>.

	No 0	Slight 1	Moderate 2	Severe 3
1. General discomfort	☐	☐	☐	☐
2. Fatigue	☐	☐	☐	☐
3. Headache	☐	☐	☐	☐
4. Eyestrain	☐	☐	☐	☐
5. Difficulty focussing	☐	☐	☐	☐
6. Increased salivation	☐	☐	☐	☐
7. Sweating	☐	☐	☐	☐
8. Nausea	☐	☐	☐	☐
9. Difficulty concentrating	☐	☐	☐	☐
10. Fullness of head	☐	☐	☐	☐
11. Blurred vision	☐	☐	☐	☐
12. Dizzy (eyes open)	☐	☐	☐	☐
13. Dizzy (eyes closed)	☐	☐	☐	☐
14. Vertigo*	☐	☐	☐	☐
15. Stomach awareness**	☐	☐	☐	☐
16. Burping	☐	☐	☐	☐

* Vertigo is experienced as loss of orientation with respect to vertical upright.
** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.
*** Visual flashbacks: illusory (motion) aftereffects reminiscent of sensations when in the simulator.

SECTION F
YOUR EXPERIENCE OF DRIVE 4

(Please circle the number that you feel is most appropriate)

F1. How calm did you feel after DRIVE 4?

Very nervous										*Very calm*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

F2. Please tick the appropriate box that corresponds to the level of symptoms that you were experiencing <u>at their worst</u>.

	No 0	Slight 1	Moderate 2	Severe 3
1. General discomfort	☐	☐	☐	☐
2. Fatigue	☐	☐	☐	☐
3. Headache	☐	☐	☐	☐
4. Eyestrain	☐	☐	☐	☐
5. Difficulty focussing	☐	☐	☐	☐
6. Increased salivation	☐	☐	☐	☐
7. Sweating	☐	☐	☐	☐
8. Nausea	☐	☐	☐	☐
9. Difficulty concentrating	☐	☐	☐	☐
10. Fullness of head	☐	☐	☐	☐
11. Blurred vision	☐	☐	☐	☐
12. Dizzy (eyes open)	☐	☐	☐	☐
13. Dizzy (eyes closed)	☐	☐	☐	☐
14. Vertigo*	☐	☐	☐	☐
15. Stomach awareness**	☐	☐	☐	☐
16. Burping	☐	☐	☐	☐

* Vertigo is experienced as loss of orientation with respect to vertical upright.
** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.
*** Visual flashbacks: illusory (motion) aftereffects reminiscent of sensations when in the simulator.

SECTION G

G1. Please place a tick in the box next to each advertisement which you remember seeing during your drives in the simulator.

Advertisement 1

Advertisement inserted in this area ☐

Advertisement 2

Advertisement inserted in this area ☐

Advertisement 3

Advertisement inserted in this area ☐

Advertisement 4

Advertisement inserted in this area

☐

Advertisement 5

Advertisement inserted in this area

☐

Advertisement 6

Advertisement inserted in this area

☐

G2. Each group of four images below and over the following pages shows the sequence of a full motion video advertisement. Please place a tick in the box next to each advertisement which you remember seeing during your drives in the simulator.

Advertisement 1

Video advertisement sequence inserted in this area (5 images)

☐

Advertisement 2

Video advertisement sequence inserted in this area (5 images)

☐

Advertisement 3

Video advertisement sequence inserted in this area (5 images)

Advertisement 4

Video advertisement sequence inserted in this area (5 images)

Advertisement 5

Video advertisement sequence inserted in this area (5 images)

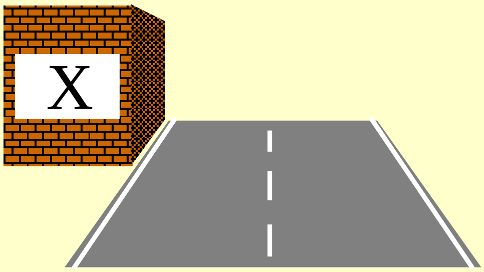
☐

Advertisement 6

Video advertisement sequence inserted in this area (5 images)

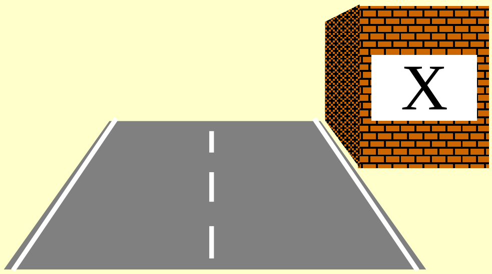
(Please circle the number that you feel is most appropriate)

G3. How distracting did you find advertising billboards placed to the left of the road?



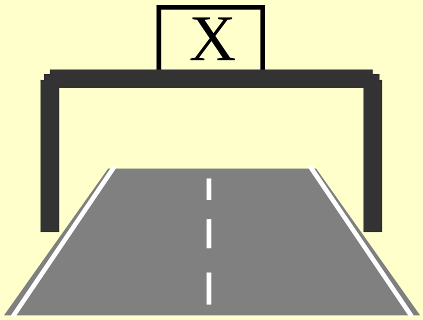
Not at all distracting										*Highly distracting*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

G4. How distracting did you find advertising billboards placed to the right of the road?



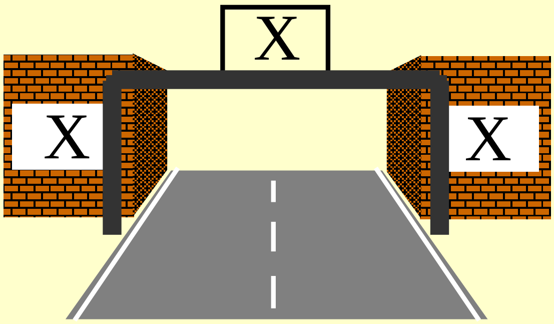
Not at all distracting										*Highly distracting*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

G5. How distracting did you find advertising billboards placed above the road?



Not at all distracting										*Highly distracting*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

G6. How distracting did you find advertising billboards placed at the left and right sides of the road, and above the road?



Not at all distracting										*Highly distracting*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

G7. How distracted do you think you would be by roadside billboards which display **STATIC** advertisements?

Not at all distracted										*Highly distracted*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

G8. How distracted do you think you would be by roadside billboards which display **FULL MOTION VIDEO** advertisements?

Not at all distracted										*Highly distracted*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

G9. How **SAFE** do you think the use of roadside billboards displaying **STATIC** advertisements is?

Very unsafe										*Very safe*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

G10. How **SAFE** do you think the use of roadside billboards displaying **FULL MOTION VIDEO** advertisements is?

Very unsafe										*Very safe*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

G11. What difference to **SAFETY** do you think use of **FULL MOTION VIDEO** advertising billboards will make?										
Much worse					*No change*					*Much better*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

G11. Please give us any general comments you have about **STATIC** and **FULL MOTION VIDEO** advertising billboards.

End of Questionnaire

Thank you very much for your participation in this study.

Appendix C Participant comments on advertising

The following italicised text is the comments taken from the questionnaire made by participants in response to the statement: "Please give us any general comments you have about STATIC and FULL MOTION VIDEO advertising billboards".

Having full motion billboards left front and right is unneeded and you can be distracted by them a lot further down the road as they are very eye catching. They can't have too much effect as I don't remember what they were now. Static boards would be ok once in a while at safe areas.

Didn't notice the billboards. I didn't notice the contents of the full motion billboards. I guess I'm an advertiser's nightmare!

In my opinion static advertising billboards distract the driver because he stops giving attention to the roads to try reading the advertising billboards and the full motion ones are much worse too me as they have flash, video etc which are very distracted.

Static you tend to just glance as where as the full motion you tend to watch for a lot longer, feels like you are made to look at it.

The static adverts didn't distract me at all but the full motion videos definitely caught my attention.

Static billboards are more distracting if they require you to read small print. Full motion billboards are very distracting as you tend to watch as much as you can before you pass them.

Static would be preferable and safer.

Although I noticed both, I tried not to be distracted by them so consequently I couldn't really say generally what was being advertised. The only ones I felt vaguely acceptable were those with very simple graphics e.g. 2+4 adverts.

Full motion adverts were more distracting as they affected me earlier on, from a longer distance but I still looked at the static ones. The full motion adverts hold your attention for longer, and the changing lights are more distracting. Empty display boards are just as distracting as static ones.

Static: I think that they are less disturbing on motorways. Full motion video: Shouldn't be allowed anywhere near roads.

Some static and some moving advertisements may be particularly eye-catching where they may, even if not aimed at the motorist, have a potential to create the impression of a pending hazard. Advertisements which show moving images more so, because they are less instantly dismissed as being truly static. I feel there is much excessive road *signage which may fall into this category. My friend in Holland knows of a town where almost all the signage has been removed and the accident rate reduced!*

I was distracted by the large white billboards displaying letters only because I have not seen the like before. Otherwise I tend not to notice ad boards. Note: this participant saw empty display boards with the ad codes on. Lena

I would imagine full motion video would be even more distracting at night time and especially to younger or less experienced drivers.

Static advertising billboards are not very distracting in singles and as long as not filling my area of vision. There are always the attraction to look to see what is advertised but I try not to look (hence I could not remember what was advertised). It is hard to ignore full motion advertising billboards and this was particularly dangerous when just behind some traffic lights. Those that are on both sides and above the road should be banned as they are very distracting and cannot be ignored! I tried not to look but the movement caught y eye and I could not avoid a quick glance which would be long enough to have an accident!

I did not notice the static boards at the side of the road at all. But I did find the full motion video very distracting. Particularly the lighter coloured advertisement.

I personally do not take a great deal of notice of static billboards motion video would distract me I think possibly making me feel sick.

During the drive I made an effort not to see distractions because of my awareness that I was on a test. But in real life I would ban them completely. They are a distraction to the driver.

Quite distracting in this simulation but don't tend to be used on the roads.

I found the full motion video advertising billboards very distracting and these were losing my concentration on the road. Static billboards are not very distracting as nothing is moving in them.

Other than legal, legitimate road signs giving instructions to motorists, advertising billboards of any sort should be kept away from the sides and above roads. Especially video signs as they could mentally confuse the eyesight and cause accidents.

Full motion video make you look at them and stop you from thinking about what is going on around you. Flashing images make you look at them - we think of flashing as a warning. Static boards you can look at like road signs and you normally recognise them without having to look longer at them. If you see them at all!

With static adverts you can possibly take in most of the image at a glance - whereas the motion adverts require a lot more attention to follow sequences etc - therefore taking attention from looking at road and pedestrians.

There's enough to watch going on in everyday life, without extra things to watch on the sideways and overhead. Static doesn't distract as much as ex extra movement going on.

I really don't find them distracting. I would have thought that I may have been distracted by adverts featuring things that interest me. However on the evidence of this simulation it appears I don't notice them!

When above the road it becomes more tempting to look at the images/videos. When L or R not so much so.

Static- would take a second glance if it was something that interested me. Didn't take eyes of road for longer than say looking at a pedestrian. Full motion - Very distracting, wanted to see complete video. Was taking eyes off road for far too long. Would be good in a traffic jam!!!....Maybe!

Static advertising billboards - Once you have looked briefly at it you've seen the entire advertisement, there's no need or compulsion to look again. Full motion billboards - More distracting because you need to look longer to see the full advert.

Static boards are fine and you soon get used to the pictures anything else, including static billboards that change adverts should only be seen at static junctions e.g. traffic lights during rush hour. Thus when the road user can not be distracted from driving safely.

Very used to seeing static advertising billboards so I didn't find theses a problem. Full motion video billboards to tend to catch your eye and may distract your attention for a few seconds.

Whilst driving in urban areas, there is a lot to distract the driver already. Adding motion videos billboards into the equation makes it more likely a driver may miss something that causes an accident. The traffic in town is slow enough now. Motion videos should be placed where your full concentration can be applied and that is not when driving.

I spent more time looking at the video billboards than the static ones. I felt I was more distracted by the videos than the static.

I tried to avoid looking at the billboards in general, but the full motion ones are more difficult to avoid.

You lose concentration very easily with full motion video. Where they are placed on left, centre and right seems to be the worst scenario. Static boards are better but not placed at road junctions where concentration is of utmost safety.

I am aware that I pay very little attention to the static billboards, but was very drawn to the moving images especially the ones which were flashing and form quite a distance away I was distracted by trying to work out what the flashing was. However, since realising it was a billboard, I wasn't necessarily drawn to watching it further to find out what it was advertising.

I don't think that static billboards are too distracting unless they are particularly eye-catching. However, I think full motion video advertising ate the side of the road could be highly distracting and potentially dangerous.

Anything that distracts a driver from concentrating on the road ahead is a bad thing, but as the eyes are particularly drawn to motion whilst driving this makes full motion video adverts very dangerous indeed. Also, the brighter and more colourful the advert, the more distracting it becomes.

When I am driving I realise how easy it is to be distracted and try very hard not to be distracted. I found the motion advertising more distracting than static but made a conscious effort to ignore them. (Reflected by the fact that I have no recall of any of the advertisements in this questionnaire)! When you're' driving a vehicle in a busy urban area being distracted for even a short period of time can be catastrophic. I could see from the scenarios that it would have been easy for people to be distracted. The advertising was clearly aimed at motorists and I feel it is wrong for the media to be allowed to try and attract the motorist's concentration on a "short film" motion advert.

Anything that takes the drivers attention away from the road for more than a few seconds like full motion video is a very bad idea. Static billboards are only glanced at and when you have seen them before you tend not to look. I remember the Wonderbra ads' and hearing reports of crashes! Sometimes not a good thing.

Investigating driver distraction: the effects of video and static advertising

Roadside advertising is a common sight on urban roads. Previous research suggests the presence of advertising increases mental workload and changes the profile of eye fixations, drawing attention away from the driving task. This study was conducted using a driving simulator and integrated eye-tracking system to compare driving behaviour across a number of experimental advertising conditions. Forty eight participants took part in this trial, with three factors examined; Advert type, position of adverts and exposure duration to adverts. The results indicated that when passing advert positions, drivers:

- spent longer looking at video adverts;
- glanced at video adverts more frequently;
- tended to show greater variation in lateral lane position with video adverts;
- braked harder on approach to video adverts;
- drove more slowly past video adverts.

The findings indicate that video adverts caused significantly greater impairment to driving performance when compared to static adverts. Questionnaire results support the findings of the data recorded in the driving simulator, with participants being aware their driving was more impaired by the presence of video adverts. Through analysis of the experimental data, this study has provided the most detailed insight yet into the effects of roadside billboard advertising on driver behaviour.

Other titles from this subject area

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