Brunel University, Uxbridge,
Middlesex, UB8 3PH, UK
Telephone +44 (0)1895 274000
Web www.brunel.ac.uk/ergonomics

Direct line: 01895 266527
Email: m.young@brunel.ac.uk

DRIVEN TO DISTRACTION: DETERMINING THE EFFECTS OF ROADSIDE ADVERTISING ON DRIVER ATTENTION

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Dr. Mark S. Young
Janina M. Mahfoud

Ergonomics Research Group
School of Engineering and Design
Brunel University

Contents

Driven to distraction: Determining the effects of roadside advertising on driver attention

Abstract

There is growing concern that roadside advertising presents a real risk to driving safety, with conservative estimates putting external distractors responsible for up to 10% of all accidents. In this report, we present a simulator study quantifying the effects of billboards on driver attention, mental workload and performance in Urban, Motorway and Rural environments. The results demonstrate that roadside advertising has a clear detrimental effect on lateral control, increases mental workload and eye fixations, and on some roads can draw attention away from more relevant road signage. Detailed analysis of the data suggests that the effects of billboards may in fact be more consequential in scenarios which are monotonous or of lower workload. Nevertheless, the overriding conclusion is that prudence should be exercised when authorising or placing roadside advertising. The findings are discussed with respect to governmental policy and guidelines.

Executive summary

Distraction in driving is a frequently cited factor in crashes. However, whilst there has been a wealth of research investigating in-car distractions, relatively little is known about distraction from objects outside the car. Roadside advertising billboards are designed by their very nature to attract attention, but the related potential threat to road safety is not acknowledged by the industry. There is evidence that drivers' visual attention is often attracted by adverts or other irrelevant objects, and if this should occur when the driver's visual workload is already high (such as at a complex junction or on a busy motorway), the driver could fail to detect more relevant signage, hazards, or potentially lose proper control of their vehicle. The consensus is that the small but significant risk to driving safety from roadside advertisements is largely underestimated. Nevertheless, the few studies conducted to date in this area have been equivocal or inconclusive in their findings, and there has not been a structured empirical investigation into this issue. The present study used the Brunel University Driving Simulator (BUDS) to conduct a rigorous test in a safe, controlled environment.

The experiment was designed to assess the effects of roadside advertising on driver attention and performance in different road types. Independent variables were the presence or absence of billboards, and the type of road – Urban, Motorway, or Rural. 48 drivers took part in the study, and all participants experienced all conditions in the simulator. Dependent variables included measures of driving performance (longitudinal and lateral control) as well as driver attention (subjective mental workload, eye movements, and recall of road signs / billboards).

In terms of driving performance, the presence of billboards had a detrimental effect on lateral control, and also appeared to increase crash risk. Longitudinal control was not affected by roadside advertising, and whilst all performance variables were influenced by the type of road, it was not possible to distinguish a particular interaction of road type with advertising. For driver attention, the results were more striking. Driver mental workload significantly increased in the presence of billboards, and on Motorway and Rural roads drivers recalled more adverts than legitimate road signs. Whilst the eye movement data did not reveal an effect for time spent looking in the direction of adverts, number of fixations significantly increased when billboards were present, suggesting a change in drivers' scan patterns.

Overall, then, the results of this study demonstrate that roadside advertising can affect driver attention and driving performance. Drivers' visual search patterns tended towards more but shorter glances in the presence of such distractors, and on Motorway and Rural roads in particular it seems that adverts are consciously attended to at the cost of more relevant road signage. Whilst the data were not so clear-cut as to offer advice for particular routes, it seems clear that the general detrimental effects on attention and performance warrant caution to be exercised when authorising or placing such billboards.

Introduction

Distraction in driving is a frequently cited factor in crashes. A recent National Highway Traffic Safety Administration (NHTSA) study provides compelling evidence of this, as distraction was found to be a factor in 78% of crashes and 65% of near-crashes (Neale *et al*, 2005; Dingus *et al*, 2005). However, whilst there has been a wealth of research investigating in-car distractions (e.g., Antin *et al*, 1990; Goodman *et al*, 1999; Jamson *et al*, 2004), relatively little is known about distraction from objects outside the car (cf. Young *et al*, 2003).

Of these external objects, roadside advertising billboards are designed by their very nature to attract attention, but the related potential threat to road safety is not acknowledged by the industry (Crundall *et al*, 2006). Basic research in the laboratory using visual search or tracking tasks has demonstrated that reaction times increase with the number of distractors and their proximity to a target stimulus (e.g., Holohan *et al*, 1978; Johnston and Cole, 1976). The implication from such studies is that roadside adverts can disrupt the identification of more relevant road signs (Castro *et al*, 2004). Horberry *et al* (2004) cite evidence that drivers' visual attention is often attracted by adverts or other irrelevant objects, and if this should occur when the driver's visual workload is already high (such as at a complex junction or on a busy motorway), the driver could fail to detect more relevant signage, hazards, or potentially lose proper control of their vehicle (cf. Engström *et al*, 2005).

Concern about the risk of distractions from billboards has grown with their prevalence in recent years, with significant coverage in the media and in UK Parliamentary debates. However, as Lord Harrison noted during his address to the House of Lords in June 2005, "too little practical or academic research has been done into the question of whether such distractions are a risk to good driving". Thus, whilst regulations and guidelines attempting to control roadside advertising do exist (e.g., the Highways Agency's 1989 Design Manual for Roads and Bridges, and the Town and Country Planning (Control of Advertisements) Regulations 1992), it is difficult to set firm policy or enforce these guidelines without data to quantify the effects on driver attention, performance, and safety.

The few studies conducted to date have been equivocal or inconclusive in their findings. Early research efforts used field data to investigate the relationship between accident rates and presence or absence of roadside billboards. Whilst Rusch (1951) did find a positive correlation, Blanche (1965) in a similar study found no association. A slightly more controlled effort was conducted by Ady (1967), who collected data from three advertisement locations before and after the adverts were in place. Only one of these locations showed an increase in accidents following placement of the advert, and Ady (1967) concluded that this was probably due to its particular conspicuity and location on a sharp bend.

More recently, a rigorous field study by Lee *et al* (2003) collected data on driver performance and visual behaviour while driving past a series of billboard sites. It was found that billboards had no effect on driver performance (in terms of speed or lane-keeping) or eye movements. It should be noted, though, that drivers were familiar with the test route, and so this may have affected their results. Conversely, Crundall *et al* (2006) found that participants watching a video of a drive spent more time looking at street-level advertisements (e.g., bus shelters) when they were supposed to be monitoring for hazards. Raised-level adverts (i.e., billboards), on the other hand, did not affect visual fixations.

It seems, then, that whilst the risk of roadside advertisements on driver attention is not nearly as great as that from in-car distractions (Lam, 2002), evidence is mounting that roadside distractions (and advertising in particular) present a 'small but significant' risk to driving safety (Lay, 2004). Conservative estimates put external distractors responsible for up to 10% of all accidents (Wallace, 2003). Based on 2004 figures, this represents around 20,000 accidents and 300 fatalities. Moreover, the consensus of opinion is that accidents caused by external distractions are largely under-reported (Lam, 2002; Wallace, 2003).

In a 2005 UK survey by Privilege Insurance, over a quarter of drivers admitted losing concentration due to roadside adverts, with 41% of those reporting that they had been distracted for *up to five seconds*. In the context of research on in-car distractions, even three-second glances away from the road were associated with extreme steering errors (Wikman *et al*, 1998). It is unsurprising, then, that nearly a quarter of all survey respondents had veered out of their lane because of roadside distractions.

On the basis of research so far, then, it is difficult to be conclusive about the risks of roadside advertising on driver distraction. Results from early field studies as well as more recent controlled experiments seem to conflict with each other, while concern about the risks is based on estimates and self-report data. It is clear that a more empirical approach is required.

Furthermore, so far there have been no structured attempts to delineate the distraction potential of billboards depending on road type. Both Lee *et al* (2003) and Crundall *et al* (2006) conducted their studies in an urban context, yet the more recent public concern in the UK is about illegal or unauthorised advertising alongside motorways. It is entirely likely that any distraction effects will differ depending on road type. We know, for instance, that different driving manoeuvres demand different levels of visual attention (Groeger, 2000). On the basis of such research, it is theoretically possible to derive a 'visual load' map of a road network (cf. Wildervanck *et al*, 1978), which may then be used to give clear guidelines on where advertising can and cannot be used. In this report, we use a driving simulator to empirically investigate these issues with the aim of supporting such guidelines.

Method

Design

The intention of this study was to determine the effects of roadside advertising (billboards) on driver attention and performance in different road environments. The Brunel University Driving Simulator (BUDS) was used to create driving scenarios for Urban, Rural, and Motorway conditions in a safe and experimentally controlled environment (cf. Young *et al*, 2003). Participants drove each of these routes both with and without billboards in a six-way repeated measures design (i.e., two levels of the billboard factor, and three levels of the road environment factor). Order of conditions was counterbalanced across participants. For the advertisement conditions, billboards were placed at semi-random locations (i.e., relatively even distances apart, ensuring that they were not covered by or covering another road sign) throughout the route. Four adverts were placed in total, three on the left hand side of the road and one on the right hand side. Figures 1 through 3 illustrate sample screenshots in each of these conditions. Note the location of the simulated rear-view mirror, which was positioned to be in line with the in-car mirror from the driver's eye-point.

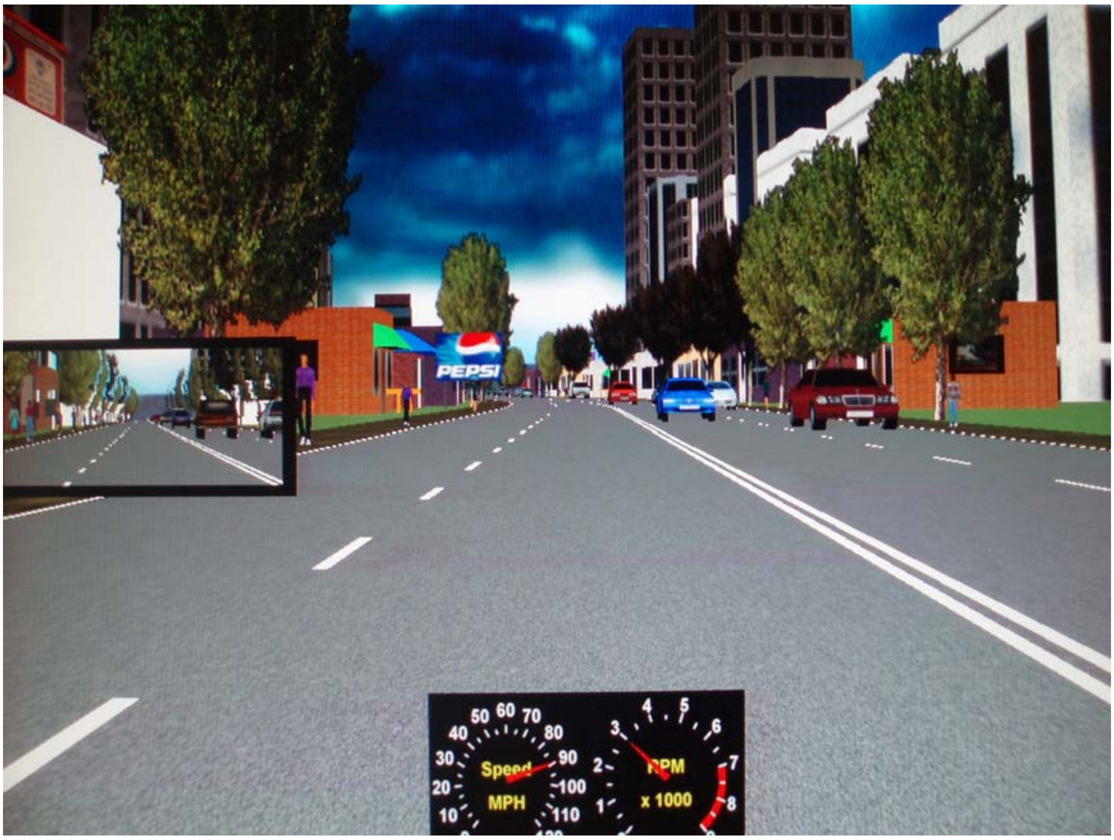

Figure 1: Sample Urban screenshot with billboards

Figure 2: Sample Motorway screenshot with billboards

Figure 3: Sample Rural screenshot without billboards

Dependent variables were chosen to evaluate both driver performance and attentional factors. Performance data were automatically recorded by the simulator software, and for the purposes of the present study several variables were of interest. For longitudinal control, time to contact (TTC) was chosen rather than speed, since the latter would have been confounded by the different road types. Both average and minimum TTC were subject to analysis. Lateral control was assessed by number of lane excursions and time spent out of lane, rather than any measure of lateral stability which can be misrepresentative of proper driving technique on curved road sections (see Young and Stanton, 2002, for a full justification). Again, due to the nature of the road types, only left edge excursions were recorded, since in this UK right-hand-drive task, excursions on the right-hand edge could have been legitimate (e.g., overtaking). Finally, total number of crashes was recorded in each condition.

Driver attention was assessed in a number of ways. Participants completed the NASA-TLX subjective workload scales (Hart and Staveland, 1988) at the end of each run, and the mean of the raw scores was used to derive overall mental workload (MWL). In addition, participants were asked at the end of the run to recall the last road sign they passed and, in the case of billboard conditions, the last advert they saw. Since perception of roadside adverts requires eye fixations (Luoma, 1988), this is indicative of their relative allocation of attention. Finally, for a more structured evaluation of visual attention, driver eye movements were recorded using the SMI iView head-mounted eye-tracking system.

Brunel University Driving Simulator (BUDS)

BUDS is a fixed-base, fully interactive, high-fidelity environment. The simulator retains the look and feel of a normal road going car, using a Ford Mondeo as the donor car, offering a realistic and immersive experience. The visual scene is projected on a large forward screen, providing a field-of-view of approximately 60 degrees horizontal and 40 degrees vertical. Audio is reproduced in Dolby Pro Logic, with a low-frequency subwoofer under the car to suggest vibration. There is authentic haptic feedback via a games console steering wheel which has been integrated in the vehicle's steering column (thus the technology is transparent and the driver interacts with the vehicle's original steering wheel and controls). These controls are connected to the simulation computer, running STISIM Drive software version 2.06.04. The computer is equipped with a 1.2GHz processor, CreativeT 3D video acceleration, high specification NVIDIA GeForce2GTST hardware and CreativeT audio hardware.

Participants

There were 48 participants (29 male) in the present study, with a mean age of 32.5 (*sd* = 13.0). All participants had held a full driving licence for at least three years (mean = 12.0) and drove an average of 10313 miles per annum (*sd* = 4789). Participants were recruited from the Brunel driver participant pool and via an email and poster campaign around the university, and they were paid £20 for their participation.

Procedure
Participants received an initial briefing about the study from the experimenter, and were given the opportunity to raise any questions or clarification points. Once they were happy to proceed, they were asked to sign the informed consent form and to take a seat in the simulator vehicle. Participants were then introduced to the eye-tracker, which was adjusted for comfort and calibration on the forward scene. A short practice run followed, during which participants were able to familiarise themselves with the control of the simulator.

Following the practice run, the six experimental trials took place. Participants were asked to drive as they normally would and to keep to the posted speed limits in each condition (40mph in Urban, 70mph on the Motorway, and 30mph in the Rural scenario). These instructions were largely successful, with actual average speeds in each condition being around 38mph, 68mph and 33mph respectively. The length of each run was 3.0 miles (Urban), 5.7 miles (Motorway) and 2.8 miles (Rural). Depending on variations in speed, each run lasted between five and six minutes duration.

After each trial, participants were immediately asked to recall the last traffic sign passed and, in the billboard conditions, the last advertisement they saw. They were also asked to complete the NASA-TLX for subjective mental workload.

At the end of all six trials, participants were fully debriefed about the experiment, were paid for their participation (and signed a receipt form), and further opportunity for questions was given. The experiment was conducted in accordance with the ethical procedures of Brunel University and the guidelines of the British Psychological Society.

Results

Driving performance data
All of the performance data (time spent out of lane, number of lane excursions, average TTC and minimum TTC) were treated to a repeated measures analysis of variance (ANOVA) with two factors: adverts (two levels) and road type (three levels). Contrasts were redundant for the adverts factor (since there were only two levels anyway), while deviation contrasts were applied to the road factor (in the absence of any sensible baseline condition).

Time spent out of lane revealed a significant main effect for road type ($F(2,94) = 15.5$; $p < 0.001$) and just reached significance for adverts ($F(1,47) = 4.04$; $p = 0.050$). The interaction was nonsignificant ($F(2,94) = 2.20$; $p = 0.117$). As can be seen in Figure 4, the presence of adverts resulted in more time spent out of lane. Analysis of the contrasts for road type reveals that significant deviations from the mean occurred for both Motorway ($F(1,47) = 18.1$; $p < 0.001$) and Rural ($F(1,47) = 15.8$; $p < 0.001$).

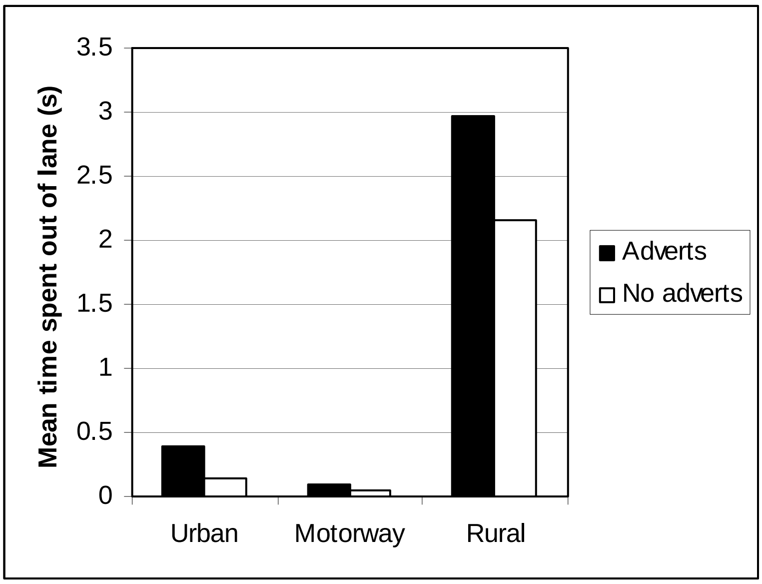

Figure 4: Time spent out of lane by road type and advert condition

A similar pattern emerged for number of lane excursions, with a significant main effect for road type ($F(2,94) = 28.7$; $p < 0.001$), and a trend towards a difference between the advert conditions ($F(1,47) = 3.10$; $p < 0.1$). There was no interaction between these variables ($F(2,94) = 1.66$; $p = 0.195$). Again, the contrasts revealed significant deviations for Motorway ($F(1,47) = 27.6$; $p < 0.001$) and Rural roads ($F(1,47) = 30.7$; $p < 0.001$), and the trend was towards more lane excursions in the adverts condition (see Figure 5).

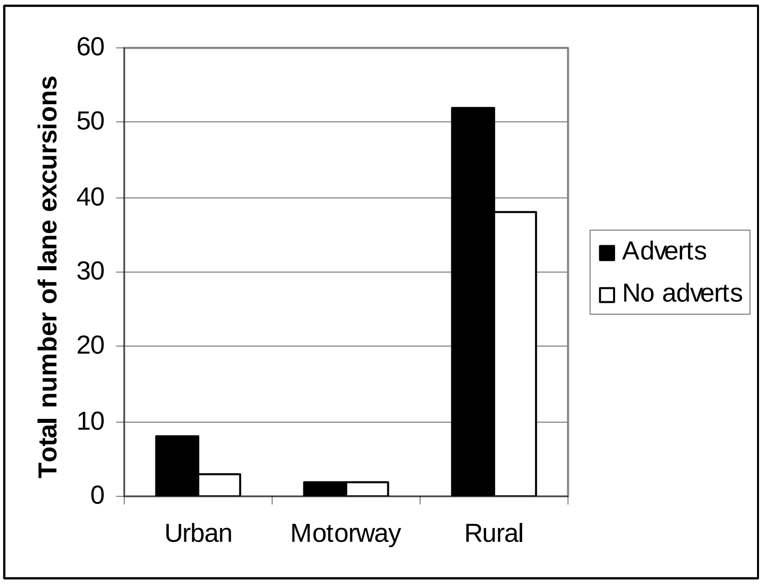

Figure 5: Number of lane excursions by road type and advert condition

The presence of advertisements did not affect either average TTC ($F(1,47) = 0.11$; $p = 0.919$) or minimum TTC ($F(1,47) = 0.988$; $p = 0.325$). Road type was significant for average TTC ($F(2,94) = 75.0$; $p < 0.001$), with contrasts demonstrating significant deviations for Motorway ($F(1,47) = 158.6$; $p < 0.001$)

and Rural roads ($F(1,47) = 17.6$; $p < 0.001$). Similarly, minimum TTC differed significantly between road types ($F(2.94) = 76.9$; $p < 0.001$), with deviations from the mean for Motorway ($F(1,47) = 37.7$; $p < 0.001$) and Rural roads ($F(1,47) = 122.6$; $p < 0.001$). Interactions between advert and road conditions were nonsignificant for both average TTC ($F(2,94) = 0.041$; $p = 0.959$) and minimum TTC ($F(2,94) = 1.363$; $p = 0.261$). Figures 6 and 7 illustrate the differences between average and minimum TTC per road type.

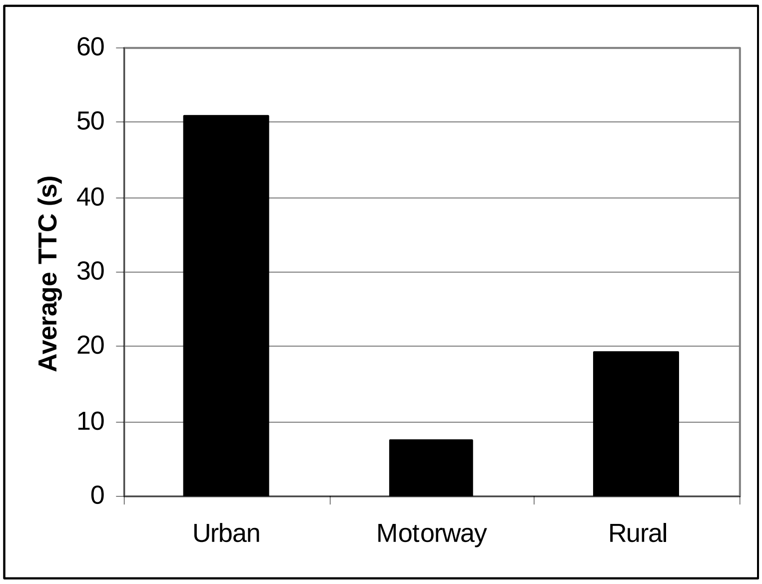

Figure 6: Average TTC by road type

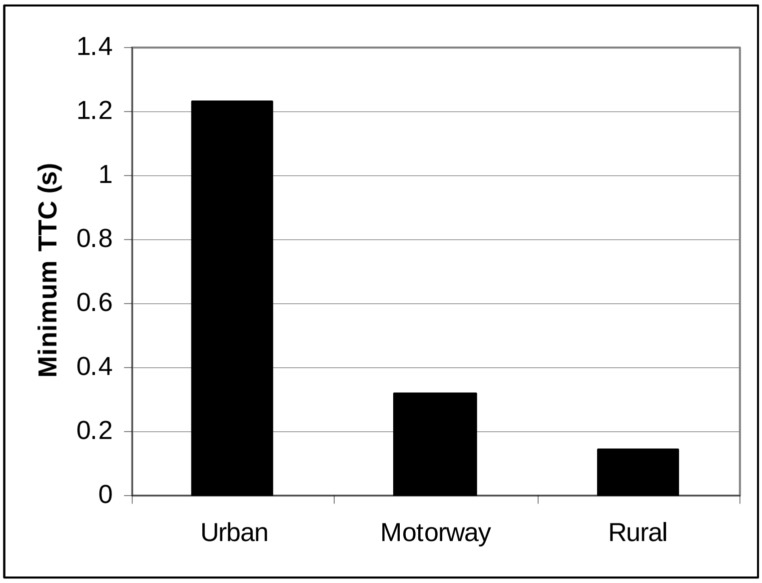

Figure 7: Minimum TTC by road type

For total number of crashes, we present descriptive data only, since the frequency counts were so low that statistical analysis was not viable. Nevertheless, as Figure 8 demonstrates, there was an indication that more crashes occurred in the presence of billboards.

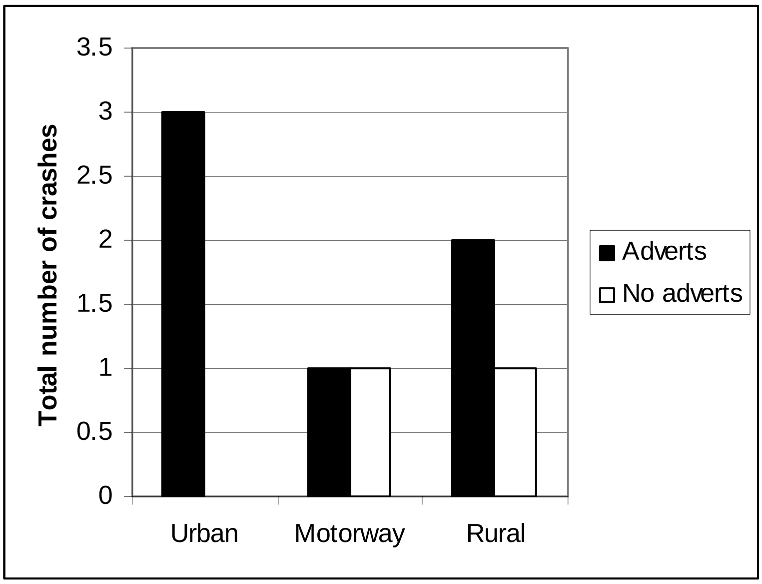

Figure 8: Total number of crashes by road type and advert condition

Driver attention data
Allocation of visual attention was assessed using the head-mounted eye-tracker. The forward screen was divided into three equal vertical sectors for the purposes of this analysis, with the middle sector representing ‘desired’ fixations (i.e., on-road); conversely the left and right side sectors were ‘undesired’ (being directed off-road and hence towards the billboards). There were two variables associated with the eye-movement data – number of fixations, and duration of glances. These were treated to repeated measures ANOVAs in the same way as the driving performance data, with left side, middle, and right side eye-movements being analysed separately. Due to technical difficulties with the eye-tracking equipment, data from a subset of 20 participants was taken forward for analysis.

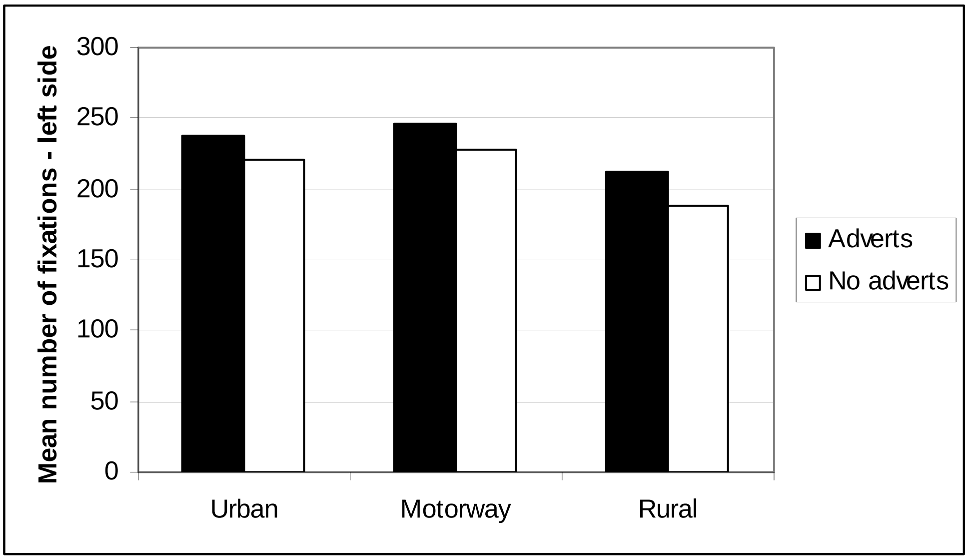

Figure 9: Mean number of fixations on the left side of the screen

Analyses of duration of glances did not reveal any significant results. However, number of fixations revealed a main effect for adverts on left side ($F(1,19) = 5.28$; $p < 0.05$), middle ($F(1,47) = 6.05$; $p < 0.05$) and right side ($F(1,47) = 6.33$; $p < 0.05$). As can be seen in Figures 9 to 11, these results all represent an increase in fixations during the advert conditions.

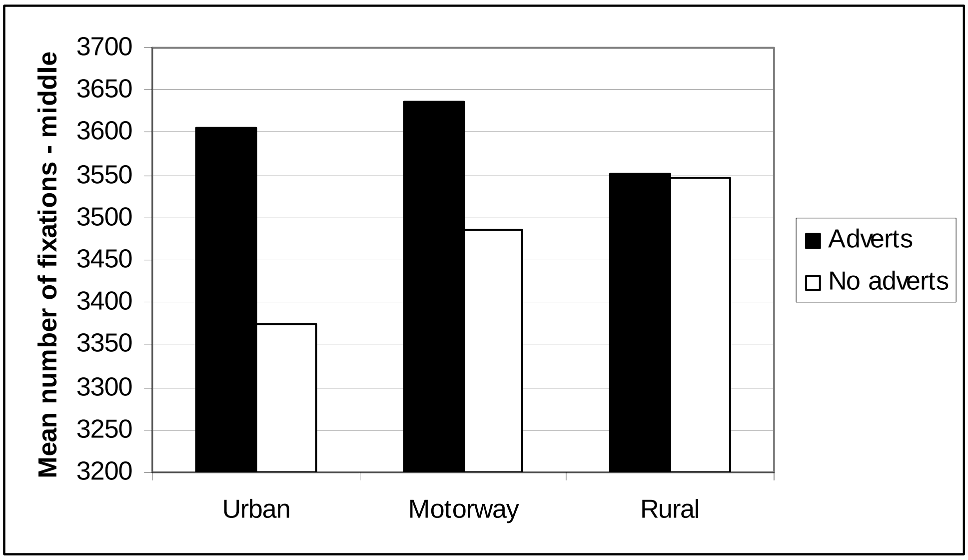

Figure 10: Mean number of fixations on the middle (roadway) of the screen

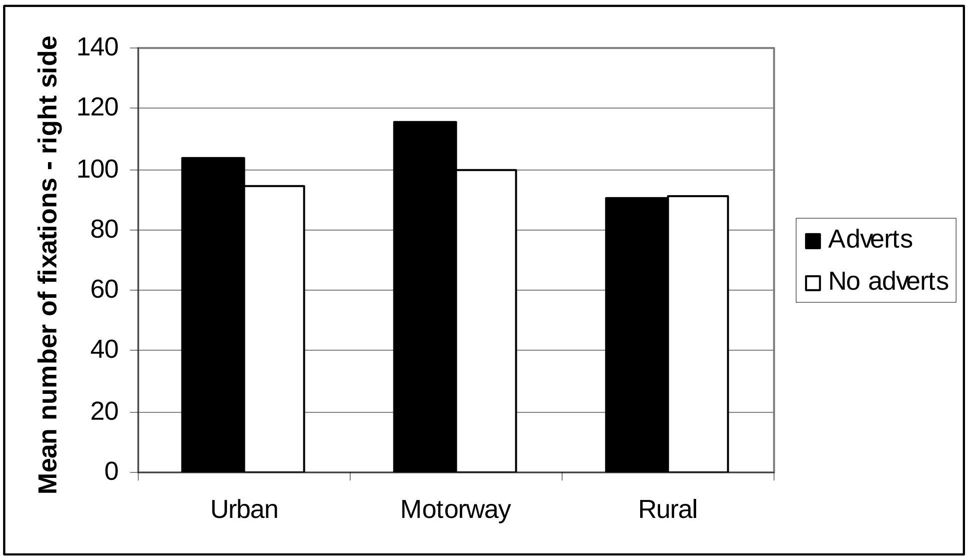

Figure 11: Mean number of fixations on the right side of the screen

The ANOVAs also revealed a significant effect of road type for left ($F(2,38) = 10.1$; $p < 0.001$) and right side ($F(2,38) = 3.78$; $p < 0.05$). Contrasts suggested that number of fixations on the Motorway were above average (left side: $F(1,19) = 7.39$; $p < 0.05$; right side: $F(1,19) = 6.79$; $p < 0.05$) and below average in Rural conditions (left side: $F(1,19) = 16.1$; $p < 0.005$; right side: $F(1,19) = 5.26$; $p < 0.05$). There was a further suggestion of an interaction between adverts and road type on right side fixations ($F(2,38) = 2.51$; $p < 0.1$).

These results were further explored with post hoc paired *t*-tests to determine whether the effect of adverts on fixations was dependent on road type – in other words, to identify specific effects of adverts within each road condition. Despite the overall significant results from the ANOVAs, only two of the comparisons reached significance at the 5% level, both within the right side fixations – for Urban ($t(19) = 2.25$, $p < 0.05$) and Motorway ($t(19) = 2.39$, $p < 0.05$) roads. Further trends at the 10% level were identified on left side fixations within the Rural condition ($t(19) = 1.89$, $p < 0.1$), and for middle fixations in the Urban condition ($t(19) = 1.74$, $p < 0.1$).

Subjective MWL data from the NASA-TLX were also treated to repeated measures ANOVAs. A significant main effect for advert condition was found ($F(1,47) = 4.84$; $p < 0.05$), with a trend towards a main effect for road type ($F(2,94) = 3.00$; $p < 0.1$). Figure 12 shows that MWL was higher in the advert conditions, and the contrasts revealed a significant deviation from the mean for Rural roads only ($F(1,47) = 5.77$; $p < 0.05$). The interaction between adverts and road type was nonsignificant ($F(2,94) = 0.739$; $p = 0.480$), as was the contrast for Motorways ($F(1,47) = 1.45$; $p = 0.234$).

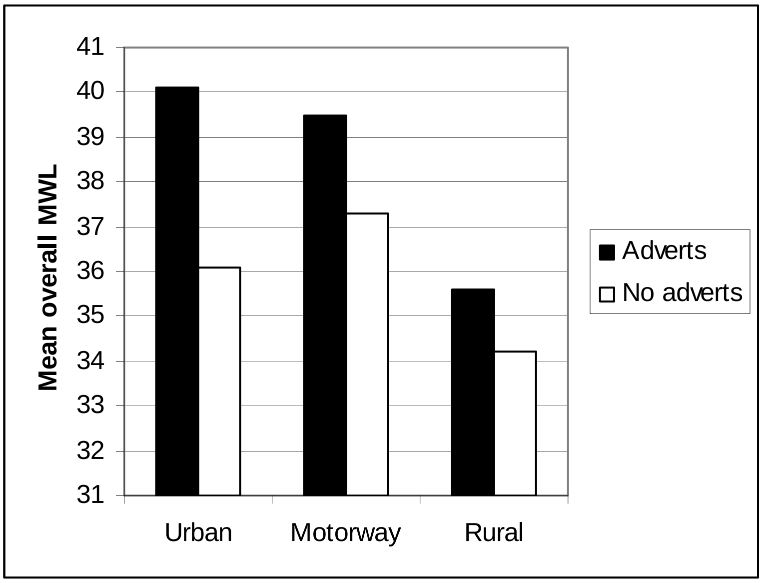

Figure 12: Mean overall MWL (NASA-TLX) by road type and advert condition

For recall of the last sign passed, responses were coded simply as correct or incorrect. These dichotomous data were then analysed using Cochran's Q test. Across all six conditions, there was a significant difference in frequency of correct responses ($Q = 15.0$; $p < 0.05$). Analysis of the relevant comparisons was carried out with McNemar tests, pairing advert and no-advert conditions within each road type. However, none of these contrasts were significant. Further investigation comparing across road types within the advert conditions revealed the source of the difference lay in the comparisons between the Urban and Motorway (*chi-square* = 9.48; $p < 0.005$) and between the Urban and Rural conditions (*chi-square* = 5.33; $p < 0.05$) only when in the presence of billboards. Frequency of correct recall in the Urban, Motorway and Rural conditions was 36, 19 and 23 respectively, as shown in Figure 13.

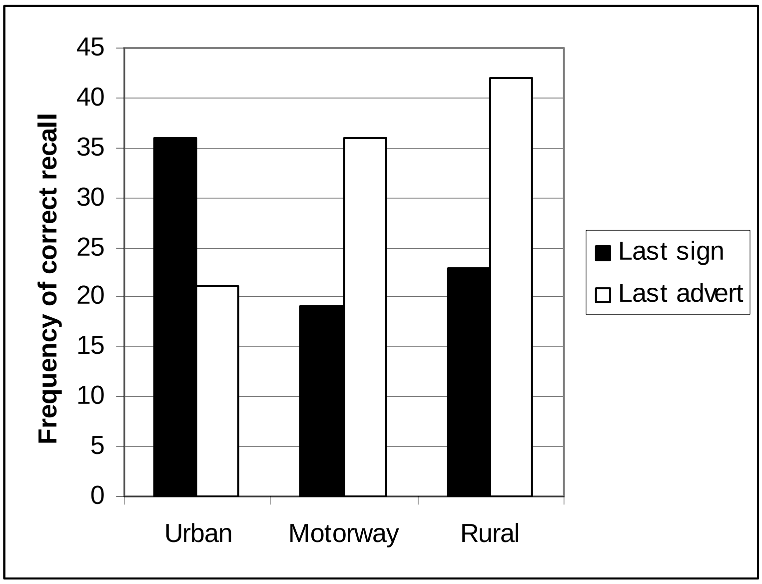

Figure 13: Frequency of correct recall for last sign and last advert passed in each road type

To explore this further, additional McNemar tests compared recall of the last billboard against the last sign in each of the advert conditions, within road type. A significant result emerged in the Urban condition (*chi-square* = 7.26; $p < 0.01$), whilst application of the binomial distribution revealed significant two-tailed tests for Motorway ($p < 0.005$) and Rural roads ($p < 0.001$). Figure 13 illustrates the frequency data for recall of last advert and last sign.

<u>Discussion</u>

As far as we are aware, this is the first study using a driving simulator to investigate the effects of roadside advertising on driver attention and performance in a controlled and empirical manner. The results indicate that the presence of billboards adversely affects driving performance in terms of lateral control and, to a certain extent, crashes. Whilst these data contradict the field results of Lee *et al* (2003), they do concord with the studies of Engström *et al* (2005) and Östlund *et al* (2006), who found that higher visual demands do increase lateral variation.

Furthermore, the evidence from this study suggests that roadside advertising can adversely influence driver attention. The presence of billboards increased overall number of eye fixations, although not total duration of glances, suggesting a change in drivers' visual attention strategies towards more but shorter glances. Wierwille (1993) noted that drivers respond to the demands of in-car tasks by altering their attention towards short glances, and the present results are in line with such findings. The presence of billboards was also associated with consistently higher subjective MWL. Moreover, recall of road signs appeared to be affected by billboards, depending on road type. Fewer road signs were correctly recalled in the Motorway and Rural conditions, and when compared with equivalent data for adverts (Figure 13), it seems that this may have been a cost of recalling more billboards (cf. Castro *et al*, 2004). In other words, drivers are attending to billboards instead of more relevant road signs. It has been suggested that novel stimuli (such as billboards) might attract attention more when the driving task itself is relatively monotonous, such as on a motorway (Wallace, 2003). This certainly seems to be true in the present study, although the conclusion is tempered by MWL data, which only showed a decrease in the Rural condition.

Other notable findings related to performance and attention on each of the road conditions. Time to contact in the Urban environment stood out as significantly higher than the other road types, which is somewhat surprising given the increase traffic in the Urban scenario. It is possible, though, that a more consistent traffic flow would keep TTC figures at a high level, rather than the 'concertina'-type braking and accelerating which may have characterised the Motorway and Urban drives. Furthermore, there were more overtakes in the Urban scenario, which would inflate TTC while there were no other vehicles in front of the subject car. Meanwhile, lateral control was substantially worse in the Rural condition. Whilst similar results have been observed elsewhere (Östlund *et al*, 2006), again it is not clear why this might be the case; task difficulty was reasonably matched across conditions (and if anything was slightly easier in the Rural scenario, as evidenced by the MWL data in Figure 12), and visual inspection of the data did not reveal any outliers of note. One explanation might be the road width – since there were additional lanes in the Urban and Motorway environments, there were fewer opportunities to drift out of lane. There was also slightly more corners, which could affect performance. Alternatively, it could reflect a level of mental underload (cf. Young and Stanton, 2002) since the Rural condition exhibited the lowest subjective MWL. In any case, it is interesting to note that this was associated with significantly fewer eye fixations, possibly suggesting a short glances strategy serves lateral control best.

Notably, one of the clearest effects of billboards was on right side fixations in Urban and Motorway conditions. Since one of the adverts was placed on the right-hand side of the road, it seems that this has attracted more glances from drivers in these conditions. Nevertheless, this is not directly associated with any specific performance effects, and it is puzzling that the decrements in lateral control for the Rural condition are not associated with differences in attention allocation (although there was a trend towards more left side fixations in the Rural condition).

These findings, whilst intriguing, do not detract from the main thrust of the study that roadside advertising can be detrimental to performance and pose a distraction for drivers. Although previous field research has been inconclusive or has not found such an effect, methodological limitations mean those results must be interpreted with caution. Even the study by Lee *et al* (2003), which was the most scientifically rigorous, used drivers familiar with the route, and who may have therefore habituated to the presence of billboards. In our study, all participants started from the same baseline and received the exact same conditions in each road type, with the only manipulation being the presence or absence of billboards. Thus we can be confident that the effects on performance and attention are directly caused by roadside advertising.

As well as furthering our knowledge on driver attention and mental workload, a key applied reason for conducting this study was to inform guidelines and policy for the placement of roadside advertising. One way of achieving this would be to develop 'visual load maps' (cf. Wildervanck *et al*, 1978) of the road environment to highlight areas where billboards may or may not be placed. However, the present data do not support such an approach. Whilst overall ANOVAs demonstrated significant results for lateral control and MWL, post-hoc paired comparisons between the advert conditions within each road type were not so revealing. For lateral control, only time out of lane for the Rural condition approached significance ($t(47) = 1.88$; $p < 0.1$). Meanwhile, MWL only showed a clear difference in the Urban environment ($t(47) = 2.08$; $p < 0.05$). This dissociation between subjective MWL and objective performance makes it difficult to provide specific advice for different road types, although some more general recommendations may still be made.

The overall effects of roadside advertising on performance and attention mean that prudence must always be exercised when authorising or placing such billboards, and perhaps especially on the right-hand side of the road (i.e., offside when driving in the left). Surprisingly, whilst MWL was higher on Urban roads with billboards, this was not associated with any particular decrements from advertising (over and above the norm); in fact, recall of road signs was better in the Urban scenario. Possibly, then, the fact that visual clutter is already high in the Urban environment means that drivers do not have spare capacity to view adverts, or actively choose to prioritise the road scene. Meanwhile, advertising on Rural roads leads to worse lane-keeping performance and can detract attention from road signs, which may be due to the lower demands of Rural driving in general. Finally, Motorway advertising can also take attention away from the driving task, although it is not specifically associated with changes in performance or MWL. It is perhaps counterintuitive, then, but these results on the whole are in line with Wallace's (2003) conclusion that adverts can affect distraction on more monotonous routes, but do not necessarily support the contention that billboards cause an additional distraction when the visual environment is already cluttered.

Notwithstanding these particularities in the data, we must once again emphasise the persuasive overall conclusion that advertising has adverse effects on driving performance and driver attention. Whilst there are sometimes conflicts of interest at Local Authority level when authorising billboards (since Councils often take a share of the profit from roadside advertising), these data could and should be used to redress the balance in favour of road safety. That balance may be changing at national level anyway. In July 2006 the UK Department for Communities and Local Government announced plans to revise regulations on outdoor adverts, in order to close loopholes on unauthorised adverts in fields on safety and environmental grounds. Needless to say, the present study supports such a move. The new regulations are scheduled to come into force in April 2007.

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