

Development Department Research Programme

External-To-Vehicle Driver Distraction

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In an increasingly complex driving environment, the potential risk of driver distraction is rising. Specifically, roadside advertising is increasingly prevalent, provocative and explicit. It is important to know whether such advertising can distract drivers from the task of safe driving. The Scottish Executive commissioned a literature review on driver distraction to explore in more depth whether external driver distraction is a significant factor in road accidents and to examine existing knowledge and gaps on the relevant external factors that cause vehicle accidents, with a view to identifying where further research might be carried out.

Main findings

- There is a large amount of scientific evidence to support the hypothesis that drivers can become distracted as they drive. Studies indicate that a substantial percentage of this distraction can be classed as 'external-to-vehicle'.
- Information from accident databases suggests that external-to-vehicle driver distraction is a major contributory factor to road accidents. However it is likely that these incidents are under-reported. The real risks may therefore be greater than official statistics suggest.
- The evidence suggests that there are two specific situations where the risk factor of billboards and signs is at its highest: at junctions, and on long monotonous roads (such as motorways).
- There is overwhelming evidence that advertisements and signs placed near junctions can function as distractors, and that this constitutes a major threat to road safety. This is because these signs create visual 'clutter' thus making it harder for the driver to perceive traffic lights and other safety signs/devices.
- It is also likely that drivers can become distracted by lights or billboards on long 'boring' stretches of road. This may be because they are 'caught by surprise' when advertisements suddenly appear, or because they fixate on them and fail to concentrate on driving.
- Overall the literature review found that advertising/billboards can function as distractors in specific situations. However, more research is needed to discover in what particular situations they pose most of a threat, and the precise extent of the risk.

Introduction

Drivers face an increasingly complex driving environment. Not only are more and more in-car electronic devices available (mobile 'phones, radio/CD/tape players and so on), but the *external* visual environment is also more complex than it was. Specifically, advertisements have become more complex, 'explicit' and prevalent in recent years. Advertisements are, of course, specifically designed to attract drivers' attention, and it is safe to assume that they succeed in doing so. The question is, do they attract attention to such an extent that safe driving is compromised?

The current research was carried out by Human Factors Analysts Ltd. (HFAL) a 'spin-out' company from the University of Strathclyde, between December 2002 and March 2003. It consisted of a literature review of all relevant material relating to external-to-driver distraction published since 1945 in English. However, it was necessary to also obtain literature relating to general theories of driver distraction and general studies of driver distraction, to provide a contextual background.

Psychological Theory

Psychological theories of driver distraction are derived from theories of *attention*. There are two main theories of attention.

The first major theory of attention was propounded by Donald Hebb in 1955. Hebb proposed that attention was a function of arousal. Arousal is a physiological state (which can be measured via EEG levels and other methods) which means roughly being excited or interested. Hebb proposed that all human beings have a need to maintain their arousal levels. This theory was amended by the psychologist D.E. Berlyne in 1960, who proposed that information modulates arousal. Therefore, human beings seek information to control their arousal levels. Too much arousal is to be 'stressed'. Too little arousal is to be 'bored'. If we are too 'bored' we will seek information to raise our arousal levels (for example, read a book, or switch on the television). Berlyne also adapted the theory of the Orientation Reaction (OR) from Pavlov. The OR is the automatic reaction of an animal to any new stimulus (a surprising noise, for example). If we are underaroused we are more likely to be 'distracted' by a new stimulus than when we are concentrating hard on a task.

The second major theory of arousal was proposed as an addition to Hebb's theory by Broadbent in 1957. Broadbent suggested that our senses have a limited 'channel capacity' and that we could easily become 'overwhelmed' by too much information. However, Broadbent's theory was challenged by Neisser, who showed that we could learn to cope with more than one form of stimulus. Neisser argued instead that attention was a skill, which could be learned.

Psychophysics Theory

More recently, work has taken place in the field of visual perception theory. Here, the debate has been concerned with whether (and to what extent), subjects can be distracted by irrelevant stimuli. Consensus is now emerging that subjects can be distracted even when they are concentrating on the task in front of them. Driver distraction is, therefore, a real possibility, even if the driver is concentrating fully on the driving task. Moreover, studies have demonstrated that in situations of high visual 'clutter', search times for important visual stimuli might be slowed down considerably. This implies that drivers may well have a similar problem in situations (such as junctions) where they have to find safety signs and traffic lights in a complex visual environment. It should be noted that measurements of reaction times have demonstrated that much distraction is unconscious: subjects' reaction times were slower when distracted even when subjects were not consciously aware that distractors were present.

Driver Distraction Studies

There are a number of studies of driver distraction *per se*. These consist of analyses of databases of accident causes (such as the National Accident Sampling System (NASS) and the Fatality Analysis Reporting System (FARS) in the USA), which were compiled from police reports, or other accident investigation reports. These reports vary in specifics. However, roughly speaking, the general conclusion is that between 10% and 30% of all accidents have driver distraction as a contributory factor, and that, of these, roughly a third are specifically caused by external-to-vehicle driver distraction. Young (aged 17-21) drivers are particularly prone to external-to-vehicle driver distraction.

It should be noted that these figures are almost certainly an underestimate. Databases are only as good as the data that is put into them, and there is much evidence that drivers will not volunteer information that will tend to incriminate them in a court of law. Therefore, drivers are unlikely to state that they were distracted by external phenomena (such as, for example, a billboard) unless there is corroborating evidence that this was the case.

Perhaps more importantly is the fact that, as demonstrated in the visual perception experiments above, much visual distraction is unconscious. Therefore, although it would be detected statistically (for example, a junction with a 'distracting' billboard would tend to have higher accident rates than one that did not), it would not necessarily be given as a contributory factor on a questionnaire.

Billboards

Studies of billboards and their effects on accident rates are of two kinds: field studies (which tend to be correlational) and laboratory studies.

Field Studies

A large number of studies have been carried out. However most of the studies are correlational, which, by definition cannot prove causality. However, the studies overwhelmingly show a relationship between accident numbers and road complexity. That is, the more complex the road (in terms of signs, junctions, number of shops, billboards, traffic rates etc.) the more likely there are to be high accident rates (note: accident rates tend to be of 'serious' or 'fatal' accidents, as problems of underreporting make analysis of minor collisions difficult).

A number of specific studies should be mentioned. In 1967, Ronald Ady carried out a 'before and after' study (*not* a correlational study) which indicated that in at least one occasion a sign was placed which led to an increase in the number of accidents. This sign was placed on a bend at the end of a stretch of road, and this fits in with Hebb's theory, that drivers were 'surprised' by a sign in such a position and that this led them to being distracted from the driving task.

Another study was carried out by Holohan in 1979. This indicated a link between accident rates and the presence of billboards at junctions. Unfortunately, this was a correlational study but its findings are borne out by the experiments discussed below.

It should be noted that not all studies show a link between accident rates and the presence of billboards. However, most do, and whilst not being absolutely conclusive, this indicates that it is highly probable that there is an effect. The Ady study (not being correlational) is the most persuasive.

Laboratory Studies

The literature search identified two major laboratory studies on driver distraction. In the Johnston and Cole (1976) study, subjects carried out a search task on a screen with a joystick whilst being distracted by advertisements. It was found that 'search times' were increased in the presence of adverts.

Holohan (1978) carried out a similar study in which a search task was carried out on a computer screen. Again, search times were lengthened with the presence of distractors. The key point seems to have been proximity: the closer the distractors were to the target object (thus increasing visual 'clutter') the longer were the search times. The *number* of distractors also had an effect, confirming this hypothesis.

Conclusions

It is clear from the various accident investigation/accident causation databases that external-to-vehicle distraction is a serious risk factor in accidents. Moreover it is likely that it is under-reported as a contributory factor, and that the actual risk factor is far higher than the reports which analyse these databases suggest.

There are (at least) two main kinds of distraction. The first is associated with visual 'clutter', and occurs mainly at junctions. Evidence for this kind of distraction is provided by the various laboratory experiments quoted above, and correlational studies (for example, the Holohan study).

The other main kind is associated with 'low arousal' monotonous situations, and occurs either when the driver is 'surprised' by a billboard or sign, or else when s/he fixates on it after a long period of driving. Evidence for this is suggested by the Ady study, amongst others.

However, the vast majority of data on these driving situations is either very old and/or biased towards the USA and Australia. More research in Scotland is therefore needed on both these phenomena to quantify the degree of risk they pose to drivers. However, it is suggested that the evidence surrounding the effect on driving at junctions of 'visual clutter' is of such strength that clear guidelines are required on the number and type of advertising signs/billboards, as well as traffic signs, that should be placed at these locations.

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