WHAT DO DRIVERS DO AT JUNCTIONS?

Simon Labbett
Sussex Police
Lewes, East Sussex
&
Dr. Martin Langham
User Perspective Ltd
University of Sussex
Brighton

1. ABSTRACT

This presentation provides an introduction to 'Human Factors', it highlights some of the psychological processes the brain undertakes that we use to formulate our decisions and actions. Some 95% of collisions are due to some degree of human error, this can normally be further subdivided into categories of attitude and behaviour, control skills or risk assessment. Urban environments are where drivers undertake a visual search for hazards and the crash statistics shows that this is where a high number of crashes occur. We present a summary of our work that has investigated:

1) How long will drivers search for hazards at an intersection
2) Will junction design affect the time they will spend doing it?
3) Where might experienced and novice drivers look?
4) What might they notice/ react to at a typical intersection?

This presentation will focus on our psychological limitations and discuss the concept of 'Feature Integration' and how the brain processes what we see by the creation of objects and features. This will then be developed into a real time audience participation demonstration. It will demonstrate that observation and recall depend on attention, abstraction and memory. By highlighting this fundamental limitation of our mental processing it will seek to explain why if you have five witnesses to an event why you can end up with five totally different accounts. It will also demonstrate driver processing and decision making times at junctions that can be compared to the previous audience demonstration of information processing.

2. INTRODUCTION

This introductory paper relating to human factors aims to stimulate debate between collision investigators, highway engineers, safety professionals and psychologists. The paper presents joint research between an academic organisation and police collision investigation. The paper provides an insight into the current thinking within the Human Factors profession regarding one aspect of driver behaviour – visual search at highway intersections. The topic reported here reflects the most common questions asked by collision investigators about driver behaviour. That is:-

> "What does a normal driver do at a junction – how long should they look before they see something and why can they *"look but not see"?*

So this article investigates why a driver may *'look but fail to see'* another road user (especially vulnerable users) and reports data that indicates:

- How long do drivers look for?
- Where do they look?
- What might they see?

We have selected only some examples from our work and most is published in journals, conference proceedings (available form most libraries), or technical reports available from TRL Ltd.

2.1 The looked but failed to see error

The 'looked but failed to see' error or 'looked but did not see' (Sabey and Staughton 1975, Staughton and Storie 1977) refers to a set of circumstances where a driver accounts for an accident in terms of failing to detect another road user in time to avoid a collision. The explanation of 'looking and failing to see' (L.B.F.S) also implies that the other vehicle was there to be seen by the offending driver. The term 'L.B.F.S. error' is used by Sabey to refer to accidents in which, during the post incident interview, the driver of the offending vehicle claimed not to have detected the other road user before the collision occurred. Sabey *et al.*'s (1975) found that 44% of 2,036 accidents appeared to have been produced by a perceptual error and in their judgement post accident interviews revealed that 'distraction' and 'looked but failed to see' errors were the most common form of perceptual errors made by drivers. Cairney and Catchpole (1995) estimate that 69-80% of all intersection accidents are failures by one driver to ‘see’ another until it is too late.

Rumar (1990) describes late detection or L.B.F.S. error as a common problem accounting for the majority of multi-vehicle accidents throughout Europe. A detection error is the basic cause, claims Rumar, because without detection no further processing of information, or decision processes can take place. Rumar identified two important causes of the late detection error:

- A lapse of cognitive expectation, illustrated by the failure to scan for a particular class of road user, or a failure to look in the appropriate direction.

- A difficulty with perceptual thresholds, illustrated by the failure to discern the relevant stimuli in lower levels of ambient illumination or in situations where vehicles approach in the peripheral visual field.

3. HOW LONG DO THEY LOOK FOR?

It appears a very basic question? How much resource time does a driver allocate to search for other road users at an intersection and what does this tell us about the claim that drivers ‘look’ but then fail to ‘see’ an approaching vehicle? Additionally, does the design of the junction, its visibility properties, and whether the driver is familiar (or not) with its layout affect the amount of time a driver will spend looking? The question is important for forensic practitioners who need to inform the court of the typical reaction times (for a review see Hole and Langham 1997) and search times that drivers need when transiting an intersection.

3.1 Methodology

A hidden video camera was mounted at one of two junctions. The video camera (Panasonic SVHS) was fitted with a 12x zoom lens. Two junctions 20 metres apart were selected. They had different visibility properties but a similar background. The short approach junction (SA) had no view of the main road unless the driver’s vehicle was on the give-way line. The long approach junction (LA) had an uninterrupted view of the main road for several hundred metres – see figure 1.

The junctions selected were on the University of Sussex campus. The advantage of using these junctions was that the university issues parking badges to vehicles that regularly use the campus. With such labelling (a small badge on the windscreen) a reasonable assessment could be made between those who regularly use these junctions and those who do not. The filming was conducted during the Open University Summer school when students who were unfamiliar with the locations visited the university in numbers and their vehicles did not display the university parking permit.

Figure 1 Plan view of the two junctions under surveillance

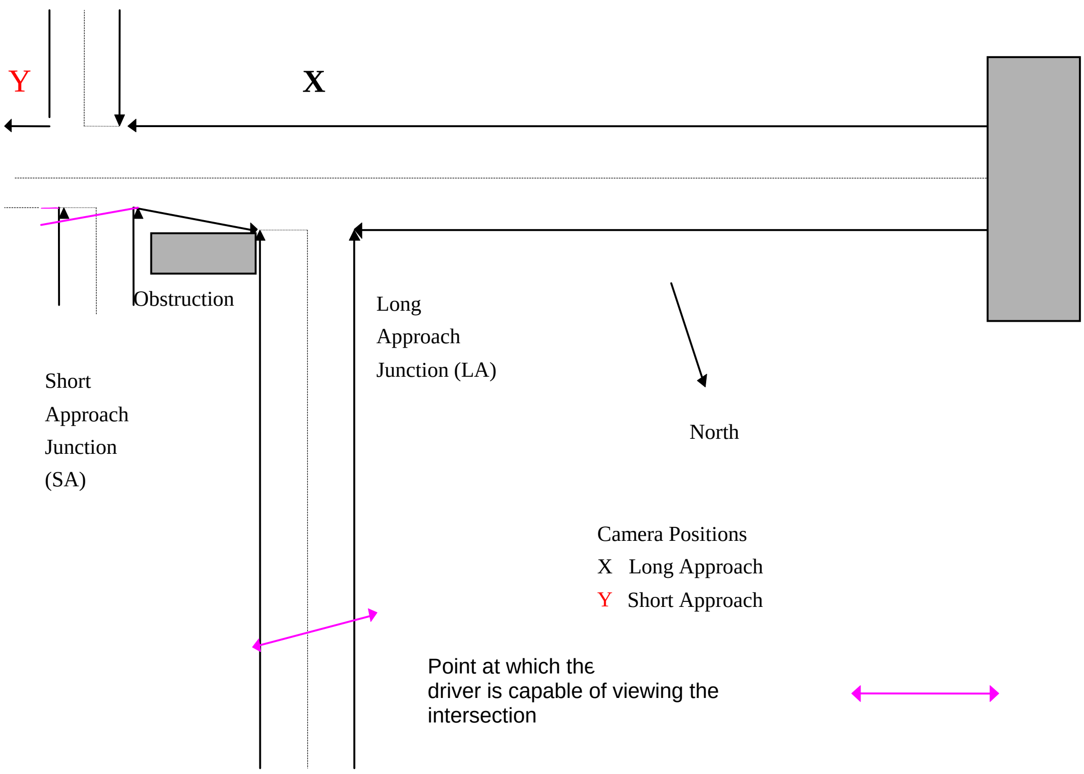

Figure 2 The view from the long approach junction

Figure 3 The restricted view of the short approach junction

3.2 Results and Discussion

The table below indicates that drivers appear to search for a very limited amount of time at an intersection. Despite the potential risks of an incomplete visual search and a failure to detect a vehicle at a junction, the drivers observed spent less than 0.5 seconds searching for hazards.

Drivers tend to search in one direction only. Drivers' behaviour is relatively constant across visibility conditions (i.e. SA and LA) and familiarity with the junction. Mean search times found imply that drivers may be conducting a rapid search of their environment and may not be attending to every detail.

The 0.5 second search time may be an indication the drivers use their limited cognitive resources to search in either limited parts of the road environment or search only for certain categories of objects for identification. The fact that mean search time was under 0.5 seconds implies that the driver is only looking in limited parts of the road and may not be individually assessing each of its constituent parts. During a short search time how much detail is the driver extracting? Is the driver reviewing every detail of the scene? Or is the driver looking for a description of what might be a hazard?

Table 1 Mean amount of time in seconds drivers spent looking for hazards at both junctions

Type of approach								
	SA				**LA**			
Driver	Mean	SD	Min	Max.	Mean	SD	Min	Max.
University	**0.4**	**0.2**	*****	**2**	**0.39**	**0.012**	**0.83**	**0.778**
Visitor	**0.44**	**0.08**	**0.4**	**1 5**	**0.36**	**0.03**	*****	**6**

*** indicates when drivers did not look.**

4. WHERE DO THEY LOOK?

One alternative explanation for the L.B.F.S. error is to suggest that drivers might be failing to direct their gaze towards parts of the road environment (e.g. Olson 1989) where vulnerable road users such as motorcyclists drive.

Rumar (1990) claims that because of driver expectancy, the driver fails to scan or look in the places where an uncommon vehicle may be present. Summala *et al.* (1996) found that a cause of bicycle collisions is that drivers developed a visual search strategy which ignores visual information about less frequent dangers.

Drivers may develop through experience a visual scanning pattern that is well suited to detect commonly-occurring vehicle types (cars, lorries and buses) but inappropriate for the effective detection of relatively rarely-seen vehicles such as motorcycles.

Despite driver interactions at junctions being a major source of collisions, most drivers do not however routinely crash at such intersections, suggesting they must be generally operating quite effectively in terms of extracting relevant information about the presence or absence of other road users and their speed of approach (Cairney *et al.* 1995). Do drivers look in the 'right' places to detect motorcycles? If drivers are using peripheral vision to detect oncoming vehicles, they might be missing motorcyclists because they are too small to be detected or because peripheral vision is poor at recognising form (Olson *et al.* 1979).

What might they see?

We sample from our environment in a series of relatively brief fixations which move from one point to another via a series of rapid jerks known as saccades. We can look at whatever we choose. Consequently this control over saccadic movements has been seen as an overt indicator of hidden cognitive processes (Chekaluk, *et al.* 1992). Sequences of fixations are a popular way of emphasising the link between overt behaviour and higher mental activities namely the presence of a temporal structure for planned fixation sequences (See Zingale and Kowler, 1987).

We therefore conducted a laboratory investigation examining where drivers look at the intersection we describe above.

4.1 Methodology

Film recording and editing were performed by a professional film crew. The stimuli consisted of eight two-second video clips (each lasting for 48 video frames), displayed onto a white screen 1.1 metres away from the experimental participant. Video clips were first generation copies. Clips were separated by ten second gaps. Participants (7 novice drivers and 7 experienced drivers) were informed of a clip's onset by a three second counter (black digits on a white background) similar in nature to a film start timer code, which appeared in the centre of the screen. The participants then viewed the eight two-second video clips.

The video clips showed several different types of junctions, including six scenes of a 'T' junction and one scene of a roundabout. The eight clips used contained either traffic coming towards the driver, going away from the driver or contained no moving vehicles. Video clips were played on a Panasonic SVHS video recorder, and projected onto a 2m x 2m white screen by a Bell and Howell SVHS L.C.D projector. The resultant image was 31° horizontal and 22° vertical. Participants wore the 'Sussex Eyemark' eye-tracking equipment (for a full description see Land 1992). This consists of a head-mounted Panasonic penlight camera which records both the scene in front of the wearer and an image of the wearer's eye (via a small half-silvered mirror mounted beneath the eye).

4.2 Results and Discussion

Figure 2 shows a representative search pattern of two different types of driver. One of the participants is an experienced driver and the other is new to driving. Although the experimental participants were allowed two seconds to search the image for other road users very different search patterns were found between novice and experienced drivers. The experienced drivers tended to fixate on only small areas of the screen whilst novice drivers tended to search many parts of the scene. The images presented here are of only two participants but are representative of all those who took part in the experiment.

Figure 4 Illustrates a typical fixation pattern of a experienced driver (in red) and a novice driver (in blue)

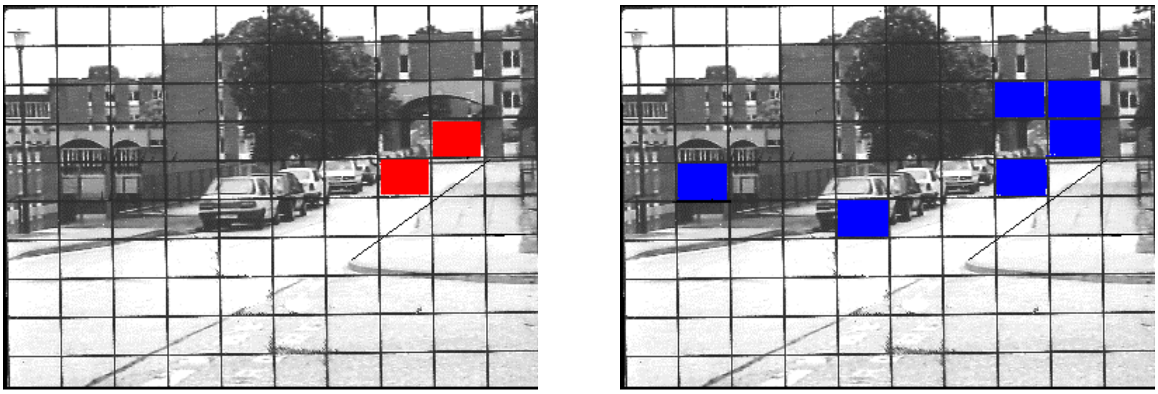

Figure 5 Illustrates the search pattern and order in which fixations are made when a vehicle is present. The blue number boxes represent the novice driver and the red numbered boxes represent the experienced driver. The numbers in each of the boxes represent the order in which fixations were made.

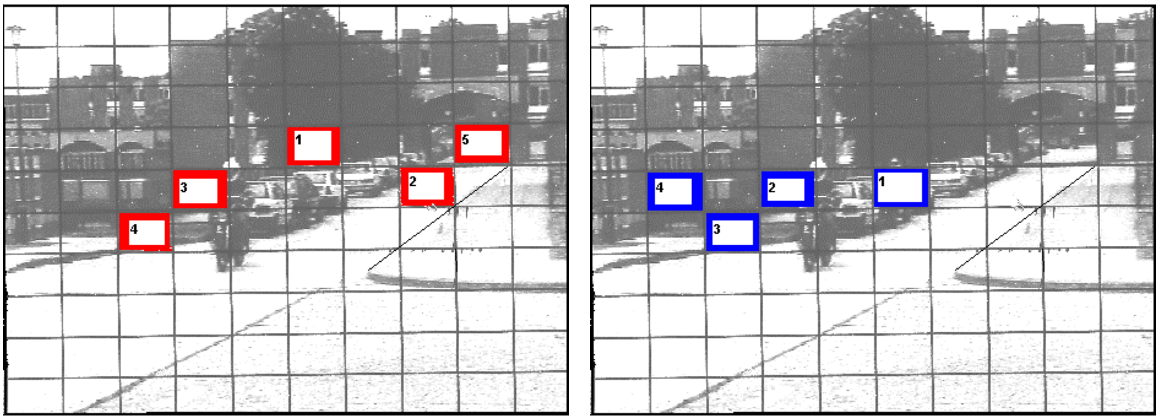

Figure 3 shows that where drivers look first and the subsequent locations to which they fixate may be determined by experience. The two experimental participants shown here are generally representative of their groups. The data may indicate that experienced driver fixate in areas of the road environment that 'experience' has taught them where hazards can be found. The novice driver here actually detected the moving motorcyclists more rapidly than did the experienced participant.

5. WHAT MIGHT THEY SEE?

To conclude the presentation we will discuss the concepts of 'Feature Integration' and 'Change Blindness' and how these concepts may further contribute to some 'look but fail to see collisions'. Feature integration seeks to introduce the process of abstraction of visual information. Change blindness demonstrates and further highlights how little information we actually abstract from our environment and how a momentary break in the visual process can lead to significant change in what we see being otherwise unobserved.

5.1 Feature Integration

When designing an intervention measure to assist in reducing collisions consideration maybe being given to the placement of signs or a change of layout. It is therefore useful in this paper to introduce how as humans we process visual information and also to highlight our limitations.

The human ability to detect apparent motion is strong, perhaps related to the concept of prey or predator for survival (Ramachandran & Antis 1986). The brain has an extensive, but not an exhaustive, capacity to process visual images, thus, the brain must select to perceive, (Treisman and Gelade, 1980). The theory of Feature-integration proposes that there are *features* and *objects*, the background features are automatically extracted and assembled into objects. Features require little processing, yet details of objects require to be taken into attention and abstracted. For example, take a view of a meadow, wherever an observer looks the visual field is full of background visual information but it lacks specific detail. When the observer studies the view further an oak tree and a black and white cow maybe identified within the general meadow setting. The background features (the general meadow view) are automatically extracted but the brain has not processed any detail. The objects (the oak tree and the cow) take greater time to process and abstract before being taken into attention.

What we as individuals attend to at any time is an almost unanswerable question and is dependent on many factors. It could be the way that an object was moving, its colour, its size or something that holds an interest. (Loftus 1996). When designing an intervention scheme consideration must therefore be given to how best assure the intended information will be abstracted from the background features. Considerations are likely to focus on the colour, size, shape, movement and the time available for detection. These factors should not be considered in isolation but in conjunction with the existing complexity of the background environment in which the intervention is to be located.

5.2 Change Blindness

Change blindness is a phenomenon in visual perception in which very large changes occurring in full view in a visual scene go unnoticed. The presentation we show uses a series of static images of road environment scenes with differences in some of the images considered safety critical to illustrate this phenomenon. The changes are what road users might be expected to experience during driving such as different traffic signal displays, approaching vehicles at an intersection, and changes in road markings.

With large volumes of information to process in our surrounding environment, we must constantly allocate or devote our attention to selective processes to be able to interpret the wealth of input available. Should we devote attention to particular elements either due to expectation (or lack of) and task demand, then we may become effectively blind to what else is happening in that environment.

For a review of change blindness literature and demonstrations see Professor Rensinks website -http://www.psych.ubc.ca/~rensink/

Figure 6 illustrates the images are task we set. Conference delegates will see an image representing a traffic scene. The first image will disappear and after two seconds and another image will appear. The image will either be the same, or would have been changed Changes will relate to road safety. Delegates need to note if the series of six pairs of images we present are the same or contain changes.

6. CONCLUSIONS AND FUTURE DIRECTION

If casualty reductions are to be sustained then it is fundamental to look beyond the physical attributes of the collision when designing effective intervention measures. Such detail is not necessarily contained in national collision records and as a result incorrect analysis of physical data can lead to inappropriate measures that fail to address significant underlying causation factors.

Understanding that humans have limited cognitive resources and rely on their expectations about the road environment should promote safety organisations and highway engineers to carefully plan their intervention measures and to think about the design of even a simple junction.

We conclude our presentation with a request that collision investigators, highway engineers, safety organisations and psychologists should talk more to each other. Each profession is still fairly insular with few conferences held to bring the professions together. A notable exception is today. Research by psychologists can have a direct impact on other professions and can contribute widely to a safer road environment.

Police collision investigators should gain a basic understanding of human factors and psychology to enable them to step into the shoes of the offending driver and understand why the incident occurred.

If police collision investigators have the correct frame of reference and knowledge of why collisions occur we can elevate their role from simple forensic investigation and reporting to that of collision prevention. Current work with Sussex police has led to improvements in night time visibility of pedestrians (Langham and Moberly, 2003), a more scientific understanding of increases in motorcycle causality rates (Labbett and Langham 2005) and improved in-vehicle design (Hampton and Langham, 2004).

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