Viewing characteristics of drivers

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**Abstract**

A number of studies have been carried out in the field of traffic safety for the purpose of accident number and fatality reduction. An accident is caused by single factors of human errors (drivers), driving environment, and vehicles, or by the combination of the three factors. In most cases it is difficult to point to one factor since it may also be influenced by another factor. As part of the human factor, drivers’ visual information is obtained from the viewed objects in the field of vision. This information is regarded as prime information since it plays a vital role in the decision making. It is therefore important to study the visual behaviour and the distribution of attention of drivers during a driving task. A number of previous studies have been carried out using a driving simulator. This paper discusses the drivers viewing characteristics based on a real driving experiment to obtain the distribution of visual attention, what drivers look at, viewing time, fixation time and viewing frequency.

**1 Introduction**

An accident can be defined as an inevitable, undesired, unexpected incident or that causes damage, or loss of property or human lives. Traffic accidents may involve a single object/subject or more. In terms of accident causation, the occurrences of accidents can be categorized into three groups, namely, human (errors) factors, vehicles and driving environment. In most of the accident records human factors are usually responsible for the biggest percentages of accidents. It is oftentimes difficult, however, to determine the single factor of an accident as in most cases accidents happen due to the combinations of
contributing factors. Some experts may also suggest that each factor is responsible 100 percent in an occurrence; it may not be appropriate to blame the tire of an overskidding vehicle as higher ability of the driver and better skidding resistance of the road surface may have prevented it from happening.

The drivers decision process includes the classical chain of sensing, perceiving, analyzing, deciding and responding. The vehicle response to the action taken by the driver is a function of vehicle characteristics and the road environment. In the Human-Vehicle-Environment Operating System, drivers move from one point to another in a certain period of time, taking into consideration safety, convenience and comfort. The system is also used as the guidance and control system for the vehicle. To do this, drivers must detect and select information from the general environment including visual information and translate the decision into a set of actions of the vehicle.

In this study, therefore, it was considered of paramount importance to come to a result to find out how drivers behave visually in their effort to obtain main and supporting information from the driving environment. Lack of visual information may lead to delayed reaction, wrong decision and wrong maneuver and may lead to accident occurrence.

2 Aim of Works

The aim of this work is to study how drivers behave visually during a driving task in a familiar route without being given instructions. This study tries to find out how drivers obtain information through their field of vision and to find out the drivers visual behaviour during a driving task. This is not, however, intended to see the attentional level of the viewed objects as it requires a more complicated work to quantify this mental work.

3 Method

The study used an Eye Mark Recorder which recorded the movements of both eyes simultaneously. The equipment was worn by the subjects of experiments during driving. Eye Mark Recorder is a set of equipment with a small video camera which records the eye movements into video cassettes and converts the signals into two different symbols. The results were then analysed to see what objects viewed and the length of the fixation time. The study was conducted at a four-armed intersection, and recordings were made during approaching time both in congested and non-congested conditions. Subjects were asked to drive as normally as possible, and a familiarization session was carried out prior to the experiment in order to eliminate the effects of unfamiliarity on the viewing behaviour. Subjects were also asked to try on the helmet until he/she got used to wearing the equipment.
4 Results

The four subjects carried out the experiment at a 4-arm intersection approach, left turn, in different traffic conditions; Subject 1 drove in a non-congested condition whereas Subjects 2, 3, and 4 drove in congested conditions. Objects viewed were classified into:

A : Traffic lights on arm 1
B : Traffic lights on arm 2
C : On-coming vehicles
D : Traffic lights of arm 3
E : Cyclist
F : Traffic signs
G : Platoon leader
H : Preceding vehicle
I : Vehicles from arms 2 and 4
J : Vehicles from arm 3
K : Road Markings
L : Vehicles in other lanes
M : Circulating/ weavning vehicles
N : Right roadside
O : Left-road side
P : Infinity
Q : Pedestrian
R : Rear-view mirror
S : Left-side mirror
T : Right-side mirror
U : Own-vehicle
V : Road ahead
W : Saccadic eye movement
X : Out of view
Y : Others
Z : Left Curb

The results of the experiment were analyzed using the video player to find out the pattern of eye movements every 20 ms (millisecond) and to categorize the information obtained into types of objects viewed, number of observations, mean fixation time and frequency of fixation time. The following figures show the results of each experiment.
Figure 1: View time and number of observations by objects viewed
Figure 2: Mean fixation time by objects viewed and frequency of fixation time
5 Findings

5.1 Non-congested condition

In a non-congested condition, it was found that the subject viewed only four different objects namely: preceding vehicle, road markings, road ahead, left curb. Vehicles in the same lane received the highest view time, highest number of observations and longest mean fixation time. The preceding vehicle was not viewed very long. Fixation range of 0-20 ms occurred the most frequently.

5.2 Congested condition

In a congested condition, the number of objects viewed ranges from 6 to 11 objects. The first subject viewed 11 different objects, namely: traffic lights of arm 1, cyclists, traffic signs, platoon leader, preceding vehicles, vehicles in other lanes, left road side, infinity, road ahead, saccadic eye movement, left curb. The subject viewed the preceding vehicle for the longest time and in the highest number of observations. Mean fixation time was the longest on the cyclist who was riding directly in front of the subject. The most frequent fixation time was 40-60 ms.

Subject 2 viewed only 6 different objects, namely Traffic signs, preceding vehicle, left road side, infinity, rear-view mirror, saccadic eye movements. The preceding vehicle was viewed longest, and had the highest number of observations. The mean fixation time was longest in rear-view mirror. Saccadic eye movement was found in higher percentage in terms of number of occurrences rather than view time. The traffic sign was observed only once in a very short fixation time. Highest frequencies of fixation time was found in the range of 0-20 ms, 20-40 ms and 140-160 ms.

Subject 3 viewed 7 different objects. Different from other objects, the subject viewed the platoon leader both the longest view time and highest number of observations. The longest fixation time, however, was on the preceding vehicle. Fixation time in the range of 20-40 ms, 100-200 ms, and 220-240 ms occurred the most frequently.

6 Discussion

The results indicate that in congested conditions, drivers spend most of the time looking at the preceding vehicle and/or the platoon leader, whilst in non-congested conditions drivers tend to look mostly at their own lane. The number of different objects viewed is bigger in congested conditions, where the mean fixation time is also shorter. In terms of the percentages of view time and percentages of number of observations on each object, the results reveal individual differences among drivers. The range of fixation time with highest frequency is lower in non-congested condition than in congested condition. This
finding may indicate that drivers need to obtain different visual information in different situation through various required viewing times and fixation times. From this visual information, drivers will be able to extract necessary information for the right maneuver through the PIEV stages; Perception: the process of extracting necessary information from the environment, Identification: the process through which the driver identifies the object; Emotion the process when the driver decides what action to take, and Volition or reaction: the process when the driver executes the action decided in the emotion process. Perception and reaction time is very important in car-following situations as in such situation if the required time before accident is less that PIEV time, accidents will occur.

Driver’s pattern of eye movements vary significantly with different traffic conditions. In non congested conditions, drivers look mostly at the road ahead, whilst in congested conditions the preceding vehicles are viewed the most. This may be due to the need of drivers to detect objects of relevance in different situations. Drivers must also know when and where to look for important information. Besides being able to detect objects of relevance in different traffic situations, a driver must also be able to attend to the objects for the time needed, or to take a suitable number of samples from important sources of information. For instance, a driver must focus his/her attention on a pedestrian in order to assess if he/she will try to cross the street or not, or take samples from other road users to determine their speed, direction and intention. If a driver by some reasons is prevented from doing this, then he/she will not be able to predict. This finding also supports the statement in Gopher (1992) where it is said that attention can be considered to be made up of a number of different performance elements of performance characteristics. Attention can be considered in terms of the degree to which it is focused, attention can be given to a single source of information or divided across different sources, attention can be switched from one task to another. Each of this separate characteristics of attentional performance are germane to the driving tasks where drivers are required to divide attention between the overall tasks of vehicle navigation, guidance and control, to focus on particular source of information what will happen in a traffic situation. Gopher and Kahneman (1971) found that a set of selective attentions were correlated with pilot’s training performance. Kahneman, Ben-Ishai and Lotan (1973) found that in the same test correlated with road accident involvement of bus drivers. Treat (1980) found that inattention and internal distraction were among the five most frequent reasons for an accident. Therefore it is not surprising that tests of selective attention, the ability to attend some specific aspects of the environment seem to play an important role in an accident involvement.

Comparing the conditions of close and distant car-following, in a close car-following, it is found that signs are fixated in a smaller percentage than in a distant car-following, both in terms of fixation time and the number of observations. It seems that, instead of using the signals, a driver uses the preceding vehicles as the route guidance. The existence of a preceding vehicle also leads to a tendency for centralization of eye fixations, a shorter mean
fixation time, and larger number of observations. This tendency might indicate that the existence of the preceding vehicles is perceived to be a potential hazard thus requiring that the driver have frequent glances in order to obtain information. This large number of observations may also reveal the need to judge the distance in order to maintain safe distance with the preceding vehicles. This result is also supported by Mourant et al. (1969) who stated that the visual judging of distance to be too close or too far and/or the associated control response of gas pedal and brake movements may be responsible for the increase in fixation duration while car-following.

One the main cause of accidents is drivers error in judgement of distance. When an object is seen, the driver will perceive the distance to the object through its relative size. When a driver has seen, detected and paid attention to objects and other road users in a traffic environment, then he/she must be able to make judgements about important aspects of these objects and road users, such as: speed, direction, distance and intention of other car drivers. The drivers must also make judgements about a suitable speed level, adapted to other road users behaviours and to environmental factors. Drivers will act based on the judgemental processes. Hills and Johnson (1980) found that drivers tended to underestimate high speed and overestimate low speeds. Another important judgement in driving is to decide upon a suitable distance to the vehicle in front and to make correct judgements of the distance and speed of an oncoming car in an overtaking maneuver. The relationship between perceived distance and real distance has been formulated as non-linear, where perceived distance is dependent on some viewing condition. (Mackie, 1972).

In this study, therefore, it was considered of paramount importance to come to a result to find out how drivers behave visually in their effort to obtain main and supporting information from the driving environment. Lack of visual information may lead to delayed reaction, wrong decision and wrong maneuver and may lead to accident occurrence.

7 Closing

As the visual information helps drivers decide on what kind of maneuver to make, it is of paramount importance that drivers can obtain the information clearly from the sources. The required information obtained in the visual field should not provide misleading information which may lead to drivers wrong decision. This is in particular very significant when drivers have to take immediate action in a critical situation as any confusing information may result in inevitable accidents. It is also important to note, that the visual information is not the only factor for
decision making in driving task as this information is to be processed mentally before action. Lack of visual information, weak response, which may be due to wrong perception, wrong judgement and other human factors all constitute unexpected driving performance. It is therefore important to minimize the possibility of human error to occur during driving. A good training for drivers will enable the drivers to have better judgements and right response and will also equip them with sufficient knowledge of safety driving which can be expected to establish a better driving behaviour.

References


