An explorative study of visual scanning strategies of motorcyclists in urban environment

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ABSTRACT

Motivation – To identify the objects/entities that determine the ontology of the motorcyclist's visual exploration activity, when driving in urban arterials. This ontology may form the basis for modelling the motorcyclists' visual activity in urban traffic as well as shed light in their interaction with automobile drivers.

Research approach – An explorative naturalistic field study was conducted, using the eye-tracking method, in which three experienced motorcyclists were asked to drive normally in a predefined route consisting of three road sections: motorway, avenue, local urban two way street. Immediately after driving an interview of each participant was conducted using the video assisted autoconfrontation method.

Findings/Design – The results suggest that (i) visual scan patterns of motorcyclists in urban arterials are much more vivid compared to those in motorway and extend well beyond formal signals, (ii) to minimize the cognitive effort of scanning motrocyclists seek for specific cues to monitor the future intentions of the other road users (iii) motorcyclists feel more vulnerable than car drivers, which leads them to recurring visual checks of the points of concern.

Research limitations/Implications – The results presented are based on a small sample of motorcyclists. In the near future we intend to extend our sample of participants and to perform formal protocol analysis of the a-posteriory, ,verbalizations.

Originality/Value – One of the very few naturalistic field studies of motorcyclist visual exploration activity in urban environment using eye tracking and autoconfrontation. Promises to offer fresh insights to safety measures for motorcyclists.

Take away message – Urban driving scan patterns of motorcyclists are very systematic and recurring across situations and participants. Fixation points are rarely directed to road elements as such. Fixations tend to be clearly directed at specific points (e.g. side mirrors, car wheels, rear edge of car roofs) that convey information about the other road users' state and intentions.

Keywords
Motorcyclist, driving activity, eye-tracking, urban environment, scan patterns.

INTRODUCTION

The aim of this study is to identify the objects/ entities that motorcyclists pay attention to, when driving in urban arterials. In contrast to previous visual search studies (Mourant and Rockwell, 1972; Chapman and Underwood, 1998; 1999; Crundall et al., 1999; 2004; Crundall and Underwood, 1998; Underwood et al., 2002; Recarte and Nunes, 2003; Underwood, 2007), the present analysis goes beyond the specification of the environmental visual sources that guide drivers' locomotion. Furthermore it does not subscribe to the classic view of considering the visually dense urban environment only as a source of drivers' distraction from the primary driving task. Indeed monitoring the specificity of the dense urban environment becomes the primary driving task. If one adopts this point of view, the question then becomes to identify the salient features of the urban driving environment as experienced by the motorcyclist. In other words, what are the objects and/ or entities that constitute the ontology of the motorcyclist's driving activity, when driving in different urban arterials? The present analysis is a first attempt to describe the specification of typical scan patterns. Such a description can form the basis for modelling the motorcyclists visual activity in dense urban traffic as well as informing technical and other measures for enhancing safety.

METHOD

A naturalistic field study was conducted in a dense urban environment using the eye-tracking method. A portable eye tracking device, mounted on a cycle helmet was used.

The participants (three experienced male drivers 25yrs, 33yrs and 37yrs with 5, 7 and7 year of motorcycle driving experience respectively) were asked to drive normally at a standard route (total duration ~30mim), which consisted of three road sections:

- a motorway with four lanes per direction, which was used as reference;
- an urban avenue with three adjacent lanes, per direction, characterised by dense traffic and high concentration of buildings, and
- a local urban two way street, with one lane per direction, characterized by a high concentration of commercial buildings on the road and sidewalks on both sides, causing conflicts between connector, collector and parking functions.

At the end of this process, an interview of the participants was followed, using the autoconfrontation method. Applying this method, the partcipants were asked to name the points/objects of fixations and if necessary to comment what they were thinking at that moment, while watching their own driving video. The interview sessions were voice recorded in synchronization with the video stream using screen capture software.

Raw eye-tracking data were turned into scanpaths (i.e fixations ans saccades). The resulting scanpaths were later superimposed to the original video. This processed driving video material along with the autoconfrontation video were minutely analysed in a manual manner by two of the authors.

ANALYSIS OF FIXATION PATTERNS

In the motorway, motorcyclists' fixation patterns (scan patterns) were found not to differ significantly from fixation patterns of automobile drivers, reported in earlier studies. More specifically, on straight segments of roadway, the motorcyclists spent most of their time fixating far ahead near to the focus of expansion of the scene, which is assumed to maximize his anticipation time. A proportionally fewer number of fixations were made to the road segments closer to the vehicle or to either side of the road, which is assumed to enhance lateral control (Mourant & Rockwell, 1972). Similarly, on curved segments of the roadway, the motorcyclists spent most of their time at previewing the road ahead, by fixating on the tangent point (Land & Lee, 1994) which is supposed to aid in estimating the future curvature of the road (Shinar, McDowell and Rockwell, 1977).

In contrast, in the two other road sections, a drastically different fixation pattern was observed, in terms of objects/ entities that motorcyclists fixated to, as well as in terms of the duration of fixations.

First of all, scanning patterns were characterized by periodic cycles. These cycles followed road segments, starting from the end of one intersection until the end of the next successive one. (Crosses in the avenue were signalled by traffic lights, whereas crosses in the local urban street were signalled by road signs).

More specifically, before the motorcyclists approach an intersection, the fixation pattern is somewhat similar to the fixation pattern observed in the motorway (i.e. switching between road ahead and near vehicle), however,

- visual scanning of road environment is more vivid both vertically and horizontally (almost double fixations per unit of time) and is directly targeted to objects of "potential" hazard (e.g. looking behind the trunk of trees, in front of a parked van, at abnormalities of road surface etc.);
- visual scanning of the traffic ahead, typically extends beyond the formal signals (e.g. a flashing indicator light, stop signs etc.) and is targeted to objects that not only signify but also verify and/or anticipate the future intentions of the other road users (e.g. fixating on two or three vehicles ahead to predict possible imminent manoeuvring of the vehicle in front, tracking the edge lines or the wheel of the vehicle ahead to verify its trajectory in the near future, spotting on the left mirror of the vehicle ahead and inside its cabin to identify the other driver's state of alertness, etc).

As the motorcyclists approach an intersection, an even more vivid and stable scan pattern is taking place, namely:

- by tracking with successive fixations all segments of the traffic scene but with recurrent refocusing on the crossing road to verify that the apparent intentions of crossing vehicles stay unchanged;
- by tracking with successive fixations the edge line of the vehicle ahead as well as its left or right wheel to monitor any imminent manoeuvring.

Interestingly, the above fixation pattern will be repeated until the motorcyclists have arrived at the middle of the intersection. The same also holds true in the case of overtaking a vehicle ahead. Deliberate monitoring of the vehicle being overtaken, by means of fixations and head turning, will not stop until the motorcyclists have clearly passed the so called blind zone.

Another interesting observation is that when other motorcycles appear in the foreground, fixation patterns are drastically affected. Typically they fixate to the helmet of a leading motorcyclist, seemingly paying less attention to adjacent automobiles. This phenomenon possibly indicates an attempt of the motorcyclists to minimize the cognitive effort of scanning the road/traffic environment ahead by taking advantage of the paths opened by the motorcyclist ahead. Our assumption is that this may be a typical motorcyclist strategy fostering cognitive economy.

ANALYSIS OF INTERVIEWS

Results from the three participants' interviews using the auto-confrotation method, revealed several aspects regarding the motorcylists' issues of concern when driving in urban environmnet.

First of all, it became evident that motorcyclists seek to increase their relative autonomy from the other road users and especially from adjacent car drivers. This appears clearly in the videos from the motorcyclists' position on the road, both when travelling in the urban avenue with three adjacent lanes and when travelling in the local urban two way steet. As the participants mentioned, they deliberately select to travel on the "clear" section of the road, implying that they would overtake a vehicle ahead to avoid car-following (i.e. in the urban two way street), or they would lane change and/or accelarate to avoid an overcrowded traffic scene due to other vehicles (i.e. in the avenue). This is not the case when another motorcycle appears in front. In conjunction to the findings of the fixation patterns analysis mentioned above, the participants stated that they deliberately follow the path of the other motorcyclists, especially the motorcycles of similar characteristics, because the leading motorcycles show the "clear" road sections of interest.

A second related issue is that motrocyclists seek for specific cues to monitor the future intentions of the driver of a vehicle ahead (or the drivers of the adjacent vehicles ahead). It is worth to mention that these cues are strongly related to the higher viewing height of motorcyclists compared to car drivers. In specific, the participants in our study all had an "enduro" type of motorcyle. In this type of motorcyle the driver eye-height is clearly higher than the roof of the cars. Due to the above, the motorcyclists are able to spot trafffic changes well beyond the vehicle ahead. Their privileged viewing height also makes it possible for them to monitor at the same time multiple "landmarks" (i.e. the vehicle ahead, plus two or three vehicles forward) that are positioned at different distances but lay on the same line-of-sight.

For instance, two participants claimed that they look at the rear edge of a vehicle's roof ahead, to monitor a potential change of its current trajectory. The third participant claimed that he looks at the left edge of the rear bumper of a vehicle ahead as well as at its front wheels to infer the future intentions of the driver ahead. Furthermore, all three participants stated that they deliberately look inside the vehicle ahead (e.g. fixating at the inner mirror) to verify that the driver of the vehicle ahead is aware of their presence.

It is also worth to mention, that, in urban roards, motorcyclists very rarely follow a vehicle ahead exaclty behind of it. A typical situation is to follow a vehicle ahead on the side of it. This occurs in an attempt to increase the possible disengagement paths (i.e. to increase their relative autonomy). As a consequence they frequently find themselves on the blind spot of the vehicle ahead. For this reason, a matter of concern for motorcyclists is to ensure that the driver of a vehicle ahead is aware of them.

In the avenue, a typical situation for motorcyclists is to try to pass through the queues of cars that run on two adjacent lanes, especially, when the later are moving along at low speeds due to dense traffic. In this particular case, an issue of concern for motorcyclists is to make sure that the emerging field of travel is "safe" and "sufficient". According to the participants, the limits of this field are determined by the exterior mirrors of the vehicles. Two participants mentioned that they also look at the exterior mirrors to check that the driver of the passing vehicle is aware of them. The third participant mentioned that the exterior mirrors of cars are used as landmarks to estimate whether there is sufficient place for his legs, whereas, the exterior mirrors of the SUVs or busses are used as landmarks to etsimate whether there is sufficient place for his helmet. These comments arose during the video autoconfrontation sessions and thus are in accordance with the observed fixations.

A final aspect that became evident through the interviews is that, due to the small volume of their vehicles, the motorcyclists feel less conspicuous and more vulnerable than car drivers. According to their comments, they constantly need to monitor adjacent drivers since as they said they "do not trust them". These comments are in-line with the observed fixation patterns showing recurrent fixations and head turnings towards the vehicles being overtaken well after passing the blind zone. Simlarly, waiting at a traffic light, motorcyclists deliberataly stand in front of a car to compenasate for their lower conspicuity, thus forcing car drivers to become aware of their presence.

DISCUSSION

From the above analyses some preliminary propositions can be stated. The motorcyclist's visual explorative activity can be conceptualized as an equilibrium influenced by two mutual factors: on the one hand, the much higher manoeuvring flexibility of motorcycles compared to automobiles and on the other hand, the much lower conspicuity of motorcycles compared to automobiles. This suggests that on the one hand in order to extend their opportunities for alternative paths, motorcyclists make a more vivid visual scanning of road/traffic environment (especially in urban arterials) compared to automobile drivers; and on the other hand, in an attempt to counterbalance the conspicuity problem, they develop richer ontologies regarding potential hazards that they are exposed to.

The later also implies, that motorcyclists actively try to extend their anticipatory time window by a constant monitoring of the traffic further ahead. It is an open question whether this strategy, although effective, comes with a cost of a diminished attention to the adjacent vehicles or not.

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Feelings and strategies of senior drivers: ways of coping with fear ?

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ABSTRACT

Motivation - This study explores the way senior drivers (compared to younger ones) adapt to the growing difficulties they have in being attentive and reactive when driving.

Research approach - The approach is based on video analysis and post-activity verbalisations ; we videotaped 12 subjects' natural drive in a big city, and conducted video-based interviews.

Findings - The analysis indicates that seniors are more frightened than younger drivers and less aggressive, and that they express more their emotions verbally right after the drive than mimically during the drive. We also distinguish two profiles of senior drivers: one is hyper-vigilant, hesitating and very anxious, and the other one is deliberately delegating the control and the attention to the other drivers, is quieter and has a smoother driving.

Implications and message - We conclude on the importance of the emotional comfort in the strategies of adaptation chosen by the drivers, and propose some advices for designing help systems for seniors.

Keywords
Driving, seniors, emotions, video-based interviews, attention overload, coping strategies.

INTRODUCTION

Seniors have to face a loss of some capabilities and some activities become uncomfortable for them: when driving one needs to adapt very quickly to a complex and dynamic situation constantly, evolving and very rapidly, with a lot of information that drivers need to be attentive to (other drivers, signalisations, pedestrians, motorcycles,...) and risking always an accident if one is not attentive and reactive enough.

We will analyse here how they adapt to this situation of driving which becomes uneasy to them, and we will give insights of the direction in which some help systems should be developed to assist them in this complex activity. The purpose of this paper is then to specify the nature of the feelings and strategies of elderly persons during natural driving and to observe if they are different from younger people.

Situated cognition has developed this now well-known idea that the activity is embedded in a specific context which can have an important effect on the activity itself (Suchman 1987). We then adopt a methodological stance which is based on getting observations of what is going on during the activity, analysing this activity in its context of occurrence. To this approach, we add a phenomenological viewpoint which considers also the lived experience of the users and workers (Mc Carthy & Wright 2004), by using post-activity interviews where the subject remembers the situation, with or without a video trace of the activity (Cahour 2008, Light 2006).

The lived experience is not only of a cognitive and sensorial nature but it is also of an emotional one, and our work focuses on this articulation between the way people think and act and between the way they feel.

We have already studied the driving situations where the drivers feel emotionally comfortable or uncomfortable, the cognitive and social sources of the discomforts, the coping strategies they adopt in the difficult situations (Cahour 2008) and how people feel more or less confident in the use of a cruise control system (Cahour & Forzy 2009).

We want to study here how seniors adapt to the complex situation of driving, how they feel in this situation and which are their strategies.

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