

A model of normal and impaired visual exploration while steering: a way to identify assistance needs

Isabelle Milleville¹, Camilo Charron², Jean-Michel Hoc¹, & Jean-François Mathé³

¹CNRS and University of Nantes, IRCCyN, Nantes

²University of Rennes 2, CRPCC, Rennes

³University of Medicine of Nantes, Nantes
France

Abstract

Driving relies mainly on visual landmark processing to determine a car's position and speed on the road. To be efficient, this visual information needs to be explored at the right time during the sensory-motor loop, and is restricted by task constraints. Visual exploration can be impaired for various reasons, including visuo-attentional or cognitive control disturbances in brain-injured people, the elderly, or those experiencing fatigue. The aim of this study was to determine appropriate criteria for visual exploration to develop a model of efficient visual exploration that can be implemented in cars. It may be possible to assist and alert drivers in case of decreasing performance. For this reason, a fixed-base driving simulator and an eye tracker were used to compare the visual exploration of control and brain-injured drivers. The results showed main differences between the two investigated samples: brain injured people had longer mean fixation duration, a reduction in the distance of visual exploration and spent less time in exploring surrounding objects which are not directly useful for the control of vehicle trajectory but are necessary for an awareness of the driving context. Together, these parameters can indicate the necessity of whether or not to intervene. Thus, it is possible to identify the parameters that need to be taken into account to trigger an assistance device and restore driver visuo-attentional and cognitive control capacity.

Introduction

Various driving support systems have been developed over the last ten years. Most of them are devoted to longitudinal control (e.g., Adaptive Cruise Control, ACC), although some of them have dealt with lateral control (e.g., Electronic Stability Program, ESP). Many of these devices warn the driver or partially support steering when a certain threshold is exceeded. These thresholds may be determined by examining the car's behaviour on the road, such as speed, lateral position and Time to Lane Crossing. Alternatively, one can examine driver behaviour, or more specifically, a driver's visual exploration of the road and the surrounding area. Effectively, visual exploration may be a good indicator of the necessity to intervene: indeed, it can provide two invaluable indications about the driver. The first concerns