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Does early training improve driving skills of young novice French drivers?

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ABSTRACT

The aim of this research was to study drivers' performances and divided attention depending on their initial training. The performances of young novice drivers who received early training, traditionally trained drivers and more experienced drivers were compared during a dual task consisting of a simulated car-following task and a number' parity judgment task. It was expected that, due to their limited driving experience, the young novice drivers would have more difficulty in adequately distributing their attention between the two tasks. Poorer performances by novice drivers than experienced drivers were therefore expected. The results indicate that traditionally trained drivers had more difficulties in speed regulation and maintaining their position in the lane than drivers with early training and experienced drivers. Performance impairment linked to driving inexperience was also found in the secondary task. The results were interpreted regarding the attentional resources involved in driving with a secondary task and supported the positive effects of French early training.

1. Introduction

1.1. Young novice drivers

Driving is a complex dynamic process-control activity that requires motor, visual and cognitive functions. Many factors can negatively influence the driver's behavior and cause road crashes. Among them, the youth and lack of experience are recognized as the major factors contributing to road vehicle crashes, so novice drivers are generally considered as having higher risks of road crashes. Indeed, their risk of being involved in fatal crashes – relative to the number of kilometers travelled-may be estimated as being four times greater than for experienced drivers, so road crashes are the first cause of death in young people between 18 and 25 years of age (ONISR, 2013). The experimental research also showed that driving skills increase significantly with experience (for a literature review see Mc Cartt et al., 2009). The ability to operate and control the vehicle are the first skills acquired during training – e.g. the psychomotor abilities. They are mastered in a few hours and lead to the development of cognitive and perceptual abilities (Hall and West, 1996). These – are known to improve with experience (Deery, 1999; Underwood, 2007) – are slower processes and include attentional allocation (Crundall and Underwood, 1998), matching between task demands and driving skills (Brown and Groeger, 1988) and contribute to the driver's ability to detect hazards. Furthermore, young novice drivers are more easily distracted by a secondary task while driving than all others driver age groups (Neyens and Boyle, 2007; Stutts et al., 2001). This is partly because novice drivers have more difficulties in adequately dividing their attention between two tasks (Young and Regan, 2007). In order to gain experience and therefore to reduce the risk of road crashes during the first years of driving, many European countries have established graduated driver licensing (GDL). GDL has multiple forms depending of the country and usually consist in a supervised driving with an adult before getting a license. Although the opportunity for road crashes involving early-trained drivers is limited by the relatively few miles driven, epidemiological studies pointed out that early-trained drivers are involved in crashes but this very rare (Williams et al., 1997; Baughan and Simpson, 2002; Senserrick and Whelan, 2003), notably when compared with involvement in road crashes during the first months after being licensed (McKnight and Peck,

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2002; Williams and Shabanova, 2003). Compared with traditionally trained-drivers, the risk of road crashes and crash injury for early-trained drivers decreases by 40% and 15%, respectively, during the first two years of driving (Gregersen et al., 2000).

In France, before taking the driving test, the learner has to take at least 20 h of practice lessons with an instructor (traditional training). Since 1988, in order to reduce the overrepresentation of novice drivers in road crashes, the French government has set up early training from the age of 16 years, with a progressive access to driving. The initial apprenticeship is similar to the traditional training (20 h of lessons), but the learner acquires additional experience consisting in driving with an adult for at least 3.000 km before being authorized to take the driving test. Educational meetings are also organized with the driving school. Whatever the type of training, the full driving license cannot be obtained before the age of 18 years. Every year, 775.000 young people in France get their licenses with the traditional training and 181.000 with early training (ONISR, 2013). Page et al. (2004) failed to demonstrate a difference in the risk of road crashes between these two types of French training but their sample consisted of a majority of students. The young people engaged in early training had a high socio-cultural level and could have been more aware of road risks than the general population (Chatenet and Leroux, 1999). To our knowledge, in France, only one experimental study has assessed driving skills, by type of training, just after the young people had obtained their driving license. It demonstrated that, in a driving simulator experiment, the early-trained drivers were less often involved in crashes than the traditionally-trained drivers (Damn et al., 2011). The aim of the present work is thus to complete this first approach by evaluating the impact of distraction by a secondary task on novice drivers' behavior while driving, depending on the type of training.

1.2. Driving as a divided-attention situation

The cognitive system contains a limited capacity of attentional resources which can be mobilized in different mental operations (Kahneman, 1973). In a word, Kahneman's theory establishes that the amount of attentional resources used is determined by the activation level of the information, which is a function of the activity, the subject's intentions and available resources. Reserve capacities may also be available for performing a secondary task and vary according to the main task demands and individual knowledge. The greater the task demands and the lower level of individual knowledge – as is the case for young novices in a complex driving task – the lower the reserve capacities for performing a secondary task. This balance system between task demands and individual knowledge is central in task-capacity interaction theory (Fuller, 2000, 2005) which has the advantage of predicting the driver's performance: (1) If the driver's capacity exceeds the task demands, the drivers has no difficulty in performing the task and controlling the situation; (2) If the driver's capacity is equal to the task demands, the driver is operational within the limits of his/her capacity as the task difficulty increases; (3) If the task demands exceed the driver's capacity, the task becomes too difficult and without a compensation mechanism such a as a decrease in speed, an increase in inter-vehicular distance or a change of lane position, a loss of control may occur (Fuller, 2005). Thus, all elements likely to attract the driver's attention, such as a secondary task while driving, increase the task demands and therefore its difficulty. Another way to explain the interference variability during the simultaneous execution of several tasks has been developed in the multiple resources model (Wickens, 1984, 2002, 2008), which considers several attentional modalities characterized by four factors: the code used (spatial versus verbal), the sensory modality involved (vision versus audition), the stage of information processing (encoding versus treatment versus response) and the type of response (motor versus vocal). The level of interference depends on the modalities mobilized by each task. Interference is thus greater when the simultaneous treatment of two tasks involves the same modalities – such as two visual tasks – than when each treatment mobilizes different modalities – such as one visual task and one auditory task–. The common aim of these models (Kahneman, 1973; Fuller, 2000; Wickens, 2008) is to predict the performance during the simultaneous achievement of several tasks. They can thus be applied to drivers who divide their attentional resources among various subtasks such as maintaining a stable trajectory while being careful with traffic. In addition to these subtasks, drivers frequently perform an additional task unrelated to driving and studies show that attentional failures (included inattention and distraction, see Regan et al., 2011) are involved in about 22% to 50% of road crashes (Ranney et al., 2000; Van Elslande, 2003; Klauer et al., 2006). Distraction by a secondary task while driving is thus a common component of everyday driving (Stutts et al., 2005). Indeed, in the real environment, 19% of drivers are engaged in an additional task such as speaking, eating, drinking, smoking or using a mobile phone (Prat et al., 2015; Stutts et al., 2005), and are thus placed in a divided attention situation. Studies using a driving simulator indicate that performing an additional task impairs driving performances and increases reaction time (Alm and Nilson, 1995; Andersen et al., 2011; Bian et al., 2010; Cantin et al., 2009). For example, using a mobile phone during a car-following task increases the mental load, resulting in an increase of brake response time to brake (Lamble et al., 1999) and a delay of 600 milliseconds in reaction to headway changes (Brookhuis and De Waard, 1994). The driver's distraction by an additional visual task also leads to an increase of driving errors (Young et al., 2013). This performance impairment linked to an additional task is confirmed by study carried out on real-environment (Blanco et al., 2006). Thus, when the task demands exceed the driver's capacity, a gradual decrease in performance is noted, such as difficulties in maintaining a stable trajectory in the lane (Hosking et al., 2009), avoiding an obstacle or reacting appropriately to the situation (Amado and Ulupinar, 2005; Horberry et al., 2006; Liu and Ou, 2011; Strayer et al., 2006). A decrease in the number of visual fixations on the mirrors and on the vehicle control commands is highlighted (Brookhuis and De Waard, 2010). Driving performance impairment can, however, be palliated by compensatory mechanisms such as a decrease in speed or an increase in the security distance from the lead vehicle (Brookhuis et al., 1991; Recarte and Nunes, 2003). See Table 1 for a summary of the literature present in this paper concerning the effects of dual tasks.

Driver' distraction by a secondary task during car-following situations therefore seems to be particularly relevant to the study of divided attention skills in young novice drivers. Indeed, they are overrepresented in crashes linked to distraction (Hosking et al., 2009). On the one hand they are more willing to engage in secondary tasks (Prat et al., 2015) and on the other hand, their lack of experience may be an additional distraction factor (Pradhan et al., 2011). Thus, the negative impact of an additional task while driving should be higher for young novice drivers compared to experienced drivers. Indeed, they have not yet automated motor driving subtasks, so, according to the previous theories, the nearly all of their resources are mobilized for the driving task and little or no resources are available for processing the cognitive secondary task.

The aim of this research was to differentiate the performances of young French novice drivers' on the basis of their training and to evaluate the benefits of early training on novice drivers' skills. It is also assumed that whatever the training, young novice drivers have poorer driving performances than experienced drivers and are more impaired by secondary tasks. A divided-attention task in a driving simulator was used.