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Effects of phone use on driving performance: A comparative analysis of young and professional drivers

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ABSTRACT

Phone use during driving is quite prevalent particularly among young drivers because of their risk-taking attitude and overconfidence on driving skills. Young drivers are at an increased risk because of their psychosocial status and inexperience. Therefore, performing secondary tasks during driving could be more dangerous for this group of drivers. This study aims to find the impact of conversation and texting on the performance of inexperienced young drivers (n = 25) and professional drivers (who are employed as drivers in a transport company; n = 24) with the help of driving simulator experiments. The distraction tasks are presented with two difficulty levels. A critical and comparative analysis of the driver categories is carried out with respect to their longitudinal (speed and acceleration) and lateral vehicle control (lane positioning and steering movements). Results show that young drivers compensate less and have lower longitudinal control during distracted driving. Young drivers manage to keep lesser steering reversals compared to professional drivers; but, show higher variations in lane positioning. The findings suggest that there is a higher deterioration in performance of the inexperienced young drivers during phone use. However, performance degradation of the experienced drivers is also significant, showing that higher experience cannot nullify the effects of increased workload during distracted driving.

1. Introduction

Numerous reports have shown that road accidents are increasing particularly among younger drivers (NHTSA, 2015; Urie et al., 2016; World Health Organization, 2011). Upper age limit for referring the drivers as young varies between 25 and 30 years (Scott-Parker and Oviedo-Trespalacios, 2017; Yannis et al., 2010; Yannis et al., 2014). The studies related to young drivers (age < 25 years) have documented that this age group is overrepresented in road crashes than other age groups (AAMI, 2012; NHTSA, 2015; Scott-Parker and Oviedo-Trespalacios, 2017). Compared to 2014 statistics, the accident deaths among young drivers were 9% higher in 2015, making it the highest increment in road accident deaths per year in the last 50 years (NHTSA, 2015). Young drivers' risk-taking behavior and overconfidence in driving skills are noted as influencing factors for these crashes (Scott-Parker and Oviedo-Trespalacios, 2017; World Health Organization, 2011). The risk-taking behavior of the drivers is one of the reasons behind their involvement in the secondary tasks during driving (Donmez et al., 2010; Haque and Washington, 2015; Tucker et al., 2015). For example, Tucker et al. (2015) reported that the risky behavior of texting while driving was positively related to other risky behaviors such as speeding among youth. Ignorance of the risk could also be another reason, because the young drivers involve in phone usage during driving despite knowing the negative impacts of such practices (Gauld et al., 2014; Haque and Washington, 2015; Huisingh et al., 2015; Nemme and White, 2010; Scott-Parker and Oviedo-Trespalacios, 2017; Young and Lenne, 2010). It is also shown that perception of social and psychological benefits of using phones outweigh the associated risks (Nurullah et al., 2013).

Negative impacts of phone usage on the driving performance include deteriorated control of speed, lateral positioning, situation awareness ability, increased accident probability and driving errors (Choudhary and Velaga, 2017a; Tornros and Bolling, 2006). However, it is worth noticing that some of the changes in the driving performance can be drivers' self-regulatory processes such as compensating the workload by reducing speed and increasing headway (Choudhary and Velaga, 2017b; Fitch et al., 2017; Oviedo-Trespalacios et al., 2017a; Wandtner et al., 2016).

Age is also an important factor to influence the driving performance during distracted driving (Brace et al., 2007; Guo et al., 2017; Oviedo-Trespalacios et al., 2016; Owens et al., 2011). However, examination of the distraction effects for different age groups is conducted only for

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limited parameters (e.g. speed, lane positioning, etc.) (Choudhary and Velaga, 2017b; Liu and Ou, 2011; Tornros and Bolling, 2006). Very few studies have compared the longitudinal and lateral performance among different age groups. Moreover, some studies analyzed the effects of age-related factors; but, very few of them have focused on comparing the performance of groups with different experience levels. Additionally, effects of complexity of the distraction tasks are also not examined.

The objective of this study is to explore and critically analyze the difference in driving performance of inexperienced young drivers and experienced professional drivers when they are involved in phone use during driving.

1.1. Literature review

Distracted driving performance is assessed with different parameters such as speed (Leung et al., 2012; Yannis et al., 2010), reaction time (Haque and Washington, 2014), acceleration (Chen et al., 2015; Liu and Ou, 2011), headway (Peng et al., 2014), Standard Deviation of Lane Positioning (SDLP) (Choudhary and Velaga, 2017a; Santos et al., 2005; Thapa et al., 2015), Steering Reversal Rate (SRR) (Jamson and Merat, 2005; Savino, 2009) and situation awareness (Huth et al., 2014; Kass et al., 2007). Speed, headway, longitudinal acceleration and reaction time represent the longitudinal control while SDLP, SRR, lateral acceleration and lane excursions are the common measures to examine the lateral control of the vehicle during distracted driving. All these parameters are differently affected by visual and cognitive distractions (Choudhary and Velaga, 2017a; Liang and Lee, 2010; Young et al., 2014).

1.1.1. Effects of conversation during driving (cognitive distraction)

Effect of phone conversation on driving is observed in terms of significant reduction in speed (Leung et al., 2012; Metz et al., 2015; Tornros and Bolling, 2006; Tractinsky et al., 2013), increment in headway (Yannis et al., 2010) and delayed response to the sudden events (Caird et al., 2008; Consiglio et al., 2003; Haque and Washington, 2014; Patten et al., 2004). Increased response time is an indication of performance deterioration, (Benedetto, 2012; Choudhary and Velaga, 2017c; Haque and Washington, 2014) but, reduced speed and increased headway are assumed as compensatory measures rather than performance impairments (Oviedo-Trespalacios et al., 2017a; Rakauskas et al., 2004; Reimer et al., 2014; Tornros and Bolling, 2005). Though the effect of conversation on longitudinal performance control measures is found to be similar in most of the previous studies, it is not straightforward on the lateral performance control measures. Some of the studies report significant effects of conversation on SDLP, SRR and lane excursions, whereas, few studies find the effects to be non-significant (Caird et al., 2008; Cao and Liu, 2013; Choudhary and Velaga, 2017a). More focused sight on the road ahead is one of the possible reasons for non-significant effect of conversations on the lateral control. Another possibility is the level of complexity of the testing scenario (urban/rural) or the conversation task (simple/complex conversation) in the experimental design of the studies.

1.1.2. Effects of texting during driving (visual distraction)

Texting during driving causes a considerable deterioration in driving performance (Choudhary and Velaga, 2017b; Cooper et al., 2011; Young et al., 2014). Similar to the conversation, texting also shows a significant effect on longitudinal control of the vehicle (Choudhary and Velaga, 2017a; Peng et al., 2014; Thapa et al., 2015). However, texting during driving also diverts the visual attention away from the roadway which leads to reduced lateral control (Choudhary and Velaga, 2017a; He et al., 2014; Young et al., 2014).

1.1.3. Effects of age and experience on performance during distracted driving

Driving performance during distracted driving is also affected by age and experience of drivers (Brace et al., 2007; Caird et al., 2008; Guo et al., 2017; Hancock et al., 2003; Haque and Washington, 2014; Oviedo-Trespalacios et al., 2016; Owens et al., 2011). In a review article, Oviedo-Trespalacios et al. (2016) documented that though younger drivers are found to be more inclined (than older drivers) to engage in phone tasks during driving, their performance is found to be less affected by the phone use. Some studies reported that there was no difference in speed (Reimer et al., 2011), horizontal gaze concentration (Reimer et al., 2012) and crash risk (Guo et al., 2017) for the two age groups. Zhao et al. (2013) observed that self-reported frequent phone users drove with higher speeds, more lane changes, more hard braking instances, but all these driving patterns were stable across all age groups. Few studies documented that older drivers showed more degradation in steering reversals and had longer interior glance durations while performing texting tasks during driving (Owens et al., 2011). Previously, it was reported that both younger and older drivers show more reduction in speed, increased reaction time and accident risk than mid-age drivers (Caird et al., 2008; Guo et al., 2017; Recarte and Nunes, 2003). Risky driving behavior and less driving experience are the commonly stated reasons for performance degradation of young drivers (Scott-Parker and Oviedo-Trespalacios, 2017; Tucker et al., 2015) and impaired visual perception and responses are the main reasons behind the degraded driving performance of older drivers (Charlton et al., 2013; Fofanova and Vollrath, 2011, 2012; Rubin et al., 2007; Owsley et al., 2001; Oxley et al., 2006).

To identify the effects of experience on driving performance during distracted state, few studies have compared the effects of phone use on professional and novice drivers, but the results are inconclusive (Kass et al., 2007; Klauer et al., 2014). Some studies reported that both the driving groups showed similar impairments during distracted driving (Kass et al., 2007; Stavrinos et al., 2013). Whereas, few studies highlighted that novice drivers are more affected and show greater crash risk when involved in the secondary tasks than the experienced drivers (Klauer et al., 2014; Tractinsky et al., 2013). Table 1 summarises some of the existing distraction studies.

1.2. Research gap

Though the effects of distraction due to phone use on different age and experience groups were studied previously, the performance was evaluated only with a limited number of parameters (Fofanova and Vollrath, 2011; Horberry et al., 2006; Rumschlag et al., 2015). Very few studies have focused on examining both longitudinal and lateral performance (Dozza et al., 2015; Tornros and Bolling, 2005). Additionally, most of the studies have investigated either the cognitive distraction (Haque and Washington, 2014; Beede and Kass, 2006) or the visual distraction (Yannis et al., 2014; Rumschlag et al., 2015) and very few of them have focused on levels of distraction complexity.

1.3. Research aims

To address the above-mentioned research gap, the present study aims to carry out a critical and comparative analysis of the longitudinal and lateral performance of inexperienced young drivers and professional drivers for both visual and cognitive distractions induced by phone use during driving. Within this context, the present study analyzes driving performances of both the groups on a simulated rural scenario. Texting and conversation tasks are varied with two difficulty levels to check the effects of the task complexity. The effects of demographic characteristics, driving history, phone use habits during driving and day-to-day life of the participants are also considered while analysing the performance data. The key benefits of comparing the two driving groups are: