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Road safety and distraction, results from a responsibility case-control study among a sample of road users interviewed at the emergency room

Mélanie Née[a,b,*], Benjamin Contrand[a,b], Ludivine Orriols[a,b], Cédric Gil-Jardiné[a,b,d], Cédric Galéra[a,b,c], Emmanuel Lagarde[a,b]

[a] Univ. Bordeaux, ISPED, F-33000 Bordeaux, France
[b] Univ. Bordeaux, Inserm, Bordeaux Population Health Research Center, UMR 1219, F-33000 Bordeaux, France
[c] Univ. Bordeaux, Charles Perrens Hospital, Department of Child and Adolescent Psychiatry, F-33000 Bordeaux, France
[d] CHU de Bordeaux, Pôle des Urgences Adultes, F-33000 Bordeaux, France

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ABSTRACT

Despite the complexities of the driving task, more and more drivers engage in non-driving secondary tasks that take their hands (manual distraction), their eyes (visual distraction) and/or their mind (cognitive distraction) away from their primary task. Inattention arising from external distractions has received much less consideration beyond the impact of mobile phone use. We aimed to investigate the association between distraction behind the wheel and risk of being responsible for a road traffic crash in a responsibility case-control study. The study population included 1912 drivers injured in a road traffic crash recruited in two rounds of recruitment (from April 2010 to August 2011 and from March 2013 to January 2015) in the adult emergency department of Bordeaux University Hospital (France). Responsibility levels were estimated using a standardized method. Self-reported activities among a pre-established list of potential distractions were combined into four external distraction variables: visual distraction, manual distraction, auditory distraction, and verbal interaction. A significantly increased risk of being responsible for a road traffic crash was associated with the exposure to activities that take drivers' eyes off the road (adjusted odds ratio 2.99, 95% confidence interval 1.42–6.28) and activities that take drivers' hands off the wheel (adjusted odds ratio 2.12, 95% confidence interval 1.20–3.75). No significant associations were found for verbal interaction and listening to the radio and/or singing. This study suggests that beyond the use of mobile phone, particular attention must be paid to activities that involve visual and/or manual distraction.

1. Introduction

Driver inattention and driverdistraction have been identified as major contributors to road crashes (Beanland et al., 2013; Klauer et al., 2006). According to Regan, inattention is defined as "insufficient or no attention to activities critical for safe driving" (Regan et al., 2011). According to the National Highway Traffic Safety Administration, driver inattention contributes to approximately 25% of police-reported crashes. In their review of serious injury crashes in Australia between 2000 and 2011, Beanland et al. found that 57.6% of the 340 crashes showed evidence of driver inattention. Among these inattention-related crashes, 25% resulted from distraction (Beanland et al., 2013). In 2016, a naturalistic study on 3542 drivers aged between 16 and 98 found that distraction was involved in about 68% of the 905 injurious and property damage crash events analyzed (Dingus et al., 2016). In developed countries, a long-term consistent downward trend is observed in the road mortality and morbidity, thanks to a range of factors principally comprising speed limit, seat belt use, road infrastructure and car safety improvements. The share of inattention in the remaining crashes that could not have been prevented by these means is therefore increasing.

Driver distraction is one form of inattention and can be defined as a "diversion of attention away from activities critical for safe driving toward a competing activity" (Regan et al., 2011). Despite the complexities of the driving task, it is not infrequent for drivers to engage themselves in non-driving secondary tasks that take their hands (manual distraction), their eyes (visual distraction) and/or their mind (cognitive distraction) (Klauer et al., 2006; Dingus et al., 2016; Sullman et al., 2015). These distractions have been identified as a major safety concern in road safety mostly due to the increasing use of mobile phones and other electronic devices while driving. They can be inside

* Corresponding author at: Univ. Bordeaux, Inserm, Bordeaux Population Health Research Center, Team IETO, UMR, 1219, F-33000 Bordeaux, France.
E-mail address: melanie.nee@u-bordeaux.fr (M. Née).

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(mobile phones, passengers…) or outside the vehicle (looking at billboards or people along the street).

Naturalistic driving studies, which consist in observing everyday driving behaviors with recording systems installed in the subjects' own vehicles, often investigated a large range of secondary activities which made it possible to explore distraction according to their type (e.g. manual, visual…). Among all distractions, visual distraction (e.g. cell dial with handheld phone, reading/writing, cell text) was associated with the highest risk of crash/near crash involvement (Klauer et al., 2006). The same result was found when considering crashes only (Dingus et al., 2016). However, the implementation of naturalistic studies required the recording and exploitation of large amount of driving session data which require high costs and long survey duration. Until a recent study (Dingus et al., 2016), results from naturalistic studies were often limited by the limited number of real crashes observed.

Studies based on driving simulators and epidemiological studies are less expensive and time consuming complementary approaches. While confronted with recall and social desirability biases due to self-reporting, epidemiological studies allow for the assessment of associations among a large sample of drivers who were not previously enrolled and were therefore driving their car with no risk of any behavior that would be induced by participation in a study involving real-time recording. Mobile phones use while driving has been the focus of most of those researches in the recent years (Caird et al., 2014; Haigney et al., 2000; Horrey and Wickens, 2006; Laberge-Nadeau et al., 2003; Matthews et al., 2003; McEvoy et al., 2005; Redelmeier and Tibshirani, 1997; Strayer et al., 2003), and often showed an association with the risk of being involved in a car crash, including when talking on a handheld phone (McEvoy et al., 2005; Redelmeier and Tibshirani, 1997). Until recently, talking on a handheld phone was not identified as a risky behavior in naturalistic driving studies (Klauer et al., 2005; Olson et al., 2009; Hickman and Hanowski, 2012) but this was finally confirmed when assessing real crashes only (Dingus et al., 2016).

To contribute to current research efforts on distracted driving and investigate whether the type of demand (e.g. verbal, manual…) modulates the risk of being responsible for a crash, we implemented a case-control responsibility study among a sample of injured drivers. All vehicle-drivers were included, including truck drivers and two-wheelers.

2. Methods

2.1. Study design and setting

We performed a responsibility case-control study in a population of patients involved in minor injurious road traffic crashes. Its basic principle was to compare the frequency of exposure between drivers responsible for the crash (cases) and drivers not responsible for the crash (controls). The study was conducted at the adult emergency department of the Bordeaux University Hospital (France) attended by urban and rural populations living in an area comprising more than 1.4 million people. Patients were recruited in two rounds from April 2010 to August 2011 and from March 2013 to January 2015. Patients were interviewed by trained research assistants. The interview comprised questions regarding the crash, patient characteristics, and distraction. Informed consent was obtained from all subjects.

2.2. Participants

Patients were eligible for study inclusion if they had been admitted to the emergency department in the previous 72 h for injury sustained in a road traffic crash, were aged 18 years or older, were drivers, and were able to answer the interviewer (Glasgow Coma Score = 15 at the time of interview, as determined by the attending physician).

2.3. Outcome variable: responsibility for the crash

Responsibility levels in the crash were determined by a standardized method adapted from the quantitative Robertson and Drummer crash responsibility instrument (Robertson and Drummer, 1994). The adaptation of the method to the French context has been validated and presented in a previous report (Laumon et al., 2005). The method takes into consideration 6 different mitigating factors considered to reduce driver responsibility: road environment, vehicle-related factors, traffic conditions, type of accident, traffic rule obedience and difficulty of the driving task. Compared with the initial method proposed by Drummer, the adapted method does not use 2 items: witness observations and level of fatigue, which are inconsistently available in crash police reports in France. For each factor, a score is assigned from 1 (not mitigating, i.e. favorable to driving) to 3 or 4 (mitigating, i.e. not favorable to driving). All six scores are subsequently summated into a summary responsibility score. This summary score was then multiplied by 8/6 to be comparable to the 8-factor score proposed by Robertson and Drummer. Higher scores correspond to a lower level of responsibility. The allocation of summary scores was: 8–12, responsible; 13–15, contributory; more than 15, not responsible. Drivers who were judged not responsible (more than 15) served as controls. The others (score ≤ 15) were considered to be cases. The interviewer was blind to the participant responsibility status when using questionnaire sections related to potential distraction because: 1. Responsibility score was computed during the analysis step; 2. Traffic rule obedience was reported after the distraction section.

2.4. Exposures

When interviewed, patients were asked to describe distracting events and activities that occurred just before the crash from a list of potential distracting events and activities including listening to the radio, cell phone use, navigation system use, having a conversation with passengers. We created 4 external distraction variables 1/distractions that take eyes off the road (e.g. dialing, GPS manipulation, looking at something outside the vehicle), 2/distractions that take one or both hands off the wheel (e.g. dialing, applying makeup), 3/distractions that involved verbal interaction (e.g. talking on the phone, talking with passenger, arguing) and 4/listening to the radio and/or singing (Table 1). The classification was made independently by two researchers and, in case of disagreement, they were invited to discuss and explain their choice in the presence of a third researcher until an agreement was reached.

An internal distraction indicator was added as we previously showed the role of mind wandering (i.e. thinking unrelated to the task at hand) (Galéra et al., 2012). Participants were asked to describe their thought content coupled with a numerical scale from 0 to 10 that captures the level of perturbation. A summary variable was created with 3 modalities: 1/no thought or thought unrelated to driving; 2/thought related to driving with a level of perturbation less than or equal to 4; and 3/thought related to driving with a level of perturbation higher than 4 (Galéra et al., 2012). In order to reduce memory bias, participants were given the opportunity to report their thoughts at two time points during the interview.

Potential confounders included the patient's characteristics (age, sex, socioeconomic category), crash characteristics (season, time of day, location…) and self-reported psychotropic medicine use in the preceding week. Patients were also asked how many hours they had slept during the previous 24 h. They were considered as sleep deprived if they reported sleeping less than 6 h on the previous night (Galéra et al., 2012; Farouki et al., 2014). Emotional valence was evaluated with the self-assessment manikin (SAM) tool to characterize the driver's emotional valence state (pleasure-displeasure) just before the crash. Patients were asked to tick the SAM graphic character ranging from a smiling happy figure to a frowning unhappy figure (arrayed in a nine-