Emotional reactivity: Beware its involvement in traffic accidents

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Abstract

Background:

Reducing risk attributable to traffic accidents is a public health challenge. Research into risk factors in the area is now moving towards identification of the psychological factors involved, particularly emotional states. The aim of this study was to evaluate the link between emotional reactivity and responsibility in road traffic accidents. We hypothesized that the more one's emotional reactivity is disturbed, the greater the likelihood of being responsible for a traffic accident.

Methods:

This case-control study was based on a sample of 955 drivers injured in a motor vehicle crash. Responsibility levels were determined with a standardized method adapted from the quantitative Robertson and Drummer crash responsibility instrument. Emotional reactivity was assessed with the MATHYS.

Results:

Hierarchical cluster analysis discriminated four distinctive driver's emotional reactivity profiles: basic emotional reactivity (54%), mild emotional hyper-reactivity (29%), emotional hyper-reactivity (11%) and emotional hypo-reactivity (6%). Drivers who demonstrated emotional hypo-reactivity had a 2.3-fold greater risk of being responsible for a traffic accident than those with basic emotional reactivity.

Conclusion:

Drivers' responsibility in traffic accidents depends on their emotional status. The latter can change the ability of drivers, modifying their behavior and thus increasing their propensity to exhibit risk behavior and to cause traffic accidents.

Key words: emotional dysregulation, risk behaviors, responsibility, arousal, valence.

1.) **Introduction**

Reducing the mortality and morbidity attributable to traffic accidents is a public health challenge. Many variables have been identified as potential sources of responsibility in such accidents. These risk factors can be broadly categorized into two main groups: endogenous factors, on the one hand, and exogenous ones, on the other. Among exogenous factors, some environmental factors and others depending on drivers' behavior are now well known: rain (Jung et al., 2010), drowsiness (Herman et al., 2014; Lyznicki et al., 1998), drugs and alcohol consumption (Penning et al., 2010), state of the car (White, 1986) and driving speed (Aarts and van Schagen, 2006). Moreover, external distractions such as outside distraction, smoking and object manipulation have also been identified (Bakiri et al., 2013).

Endogenous factors have been identified more recently with an increasing interest in psychological variables. These variables are of a different nature, some endowing a pathological character (e.g., depression, anxiety, stress, etc.) and others reflecting normal functioning but whose occurrence can produce a negative impact on driving activity and lead to accidents. Several studies have demonstrated the impact of endogenous factors such as internal distraction, distracting thoughts and mind-wandering (task-unrelated thought) on driving performances or on responsibility for traffic accidents. For example, Galéra and colleagues (Galéra et al., 2012) have shown that intense mind-wandering (Smallwood et al., 2009) may be associated with responsibility for a traffic crash. However, the involvement of emotional factors in traffic accidents has received little attention. Two studies evaluating specific emotional valence highlighted the emergence of two factors related to aggressive driving: (a) driving violations and (b) irritability while driving, both of which are linked to road crashes (El Chliaoutakis et al., 2002). Furthermore, road rage is one of the contributory variables to reckless driving (Sansone et al., 2010). Interestingly, aggressiveness and road rage share a common dimension, namely high emotional intensity which is part of emotional reactivity (Rowden et al., 2011). Thus, it is appropriate to assess the impact of emotional reactivity on the causes of traffic accidents. Emotional reactivity refers to the threshold for, and magnitude of, emotional responses to a given stimulus. These emotional responses typically involve changes in several response systems, including perception, feelings, expressive behavior, and peripheral and central physiology. Emotional reactivity can thus be

seen as the production of a specific affective state in response to a given stimulus and the regulation of this affective state and emotional behavior (Henry et al., 2012).

Although investigating endogenous factors like emotional reactivity empirically could be difficult, it is an important and innovative way to better understand the behavior of drivers and particularly their involvement in traffic accident, which can be hypothesized as being frequently due to a complex combination of various factors. To unravel this complex relationship between potential risk factors, the first step is to identify the potential involvement of each one on traffic accidents. To our knowledge, no study has yet used an observational epidemiological approach to describe the link between emotional reactivity and traffic crashes in the real world. The objective of this investigation was therefore to study how emotional reactivity interferes with driving by assessing the association between emotional reactivity and responsibility in a traffic accident. We hypothesized that the more the emotional reactivity is disturbed, the greater the likelihood of being responsible for a traffic accident.

2.) **Method**

2.1. Participants and setting

The study was conducted in the adult emergency department of Bordeaux University Hospital (France), which serves urban and rural populations of an area comprising more than 1.4 million people. A total sample of 887 participants was recruited from April 2010 to August 2011. Participants were included if they had been admitted to the emergency department within 72 hours after a car accident (mean time between the accident and the interview = 4 h 34 min, *Sd* = 12 h 58 min), were aged 18 or older, were drivers, and were able to answer the interviewer (Glasgow coma score 15 at the time of interview, as determined by the physician). Trained research assistants interviewed patients using a set of questions regarding the characteristics of the accident (e.g., season, driver's status, location), vigilance state (which included questions about sleep deprivation, alcohol use, psychotropic medicine use), socio-demographic characteristics (see Table1), external distracters (e.g., listening to music, phone use, etc.), emotion (see description of variables below) and several other questions mainly concerning road security. The main variables of interest were the

assessment of drivers' responsibility for the accident, which was conducted along with a survey of their activities and measure of emotional reactivity (which can be considered as a measure of arousal) and emotional state (which can be considered as a measure of valence). Participants completed the questionnaire after having provided written informed consent. The study was conducted in accordance with international guidelines for good clinical practice.

Insert Table 1 about here

2.2. Variables:

The objective of the study was to evaluate the link between emotional reactivity and responsibility in a traffic accident. The assessment of drivers' responsibility for the accident was determined according to responsibility levels in the crash with a standardized method adapted from the quantitative Robertson and Drummer crash responsibility instrument (Robertson and Drummer, 1994), using a validated French version (Orriols et al., 2010). The method considers six different mitigating factors considered to reduce drivers' responsibility: road environment, vehicle-related factors, traffic conditions, type of accident, traffic rule obedience, and difficulty of the driving task. Higher scores correspond to a lower level of responsibility. The allocation of summary scores was: 8-12=responsible; 13-15=contributory; >15=not responsible). Drivers who were assigned any degree of responsibility for the crash were considered to be cases and drivers who were judged not responsible (score >15) served as controls.

Emotional reactivity was evaluated for the week preceding the accident. Emotional reactivity score (one dimension of the MATHYS scale, Multidimensional Assessment of Thymic State) (see Henry et al., 2010, 2008, 2008 for details) varied from 0 to 40. Emotional score indicates the overall level of emotional hypo-reactivity/hyper-reactivity, with 20 as the basic emotional reactivity score. The emotional reactivity dimension indicates whether an individual feels emotion with normal intensity, greater intensity or less intensity. For each of the four items of the emotional reactivity dimension, individuals have to indicate how they feel just before the accident by marking a vertical line on a 10-cm horizontal line representing a complete spectrum from inhibition to activation, with the middle of the line representing the usual state. A score of 0 indicates emotional hypo-reactivity, whereas a score of 10 indicates emotional hyper-reactivity for the evaluated item. Emotional reactivity

concept determine whether the person's emotions are perceived less intensely than usual, possibly with feelings of emotional paralysis (regardless of the emotion considered: pleasure, anger, sadness) or whether the person feels emotionally vulnerable and feels that he or she cannot think clearly and is invaded by emotions (hyperperception, hypervigilance, hyperreactivity to the environment and syntonia). People with emotional hypo reactivity feel emotionally numb, their mood is constant, and changes little, a decrease in or absence of reactivity to the environment, as if the person is living in a bubble, neither perceiving nor reacting to what happens in his or her environment. People with emotional hyperreactivity can be more reactive to their environment than usual, they can lose control over emotions, they can be less reactive to environment than usual, their mood seems to vary a lot, depending on their environment.

Other variables were also considered because of their potential influence on the outcome variable – i.e. responsibility. These included socio-demographic variables (see table 1 for details) like sex, gender and socio-economic category and also driver's status and the number of accidents in the last five years.

2.3. Statistical analysis

The sample was divided into two groups: drivers responsible for crashes (cases) and drivers not responsible for crashes (controls) as assessed by a standardized method adapted from the quantitative Robertson and Drummer crash responsibility instrument (see presentation of variables above). Among the original sample of 887 participants, 181 (17%) were excluded from analysis because of incomplete data on the responsibility variable or on emotional status. Socio-demographic characteristics of responsible and non-responsible participants were compared using the chi-squared test for categorical qualitative variables and the independent Student *t* test for quantitative continuous ones. We systematically checked the results of the *t* test using the Wilcoxon *W* test in the event of significant deviations from normal distribution and heterogeneity of variance. For all tests, significance was set at $p<.05$, two-tailed.

In order to classify individuals according to their emotional reactivity characteristics, hierarchical cluster analysis was performed on scores obtained on the MATHYS scale. An ANOVA test was then used to assess the accuracy of classification for each dimension of the MATHYS scale (Wilson, 2005). This analysis allowed us to identified different sub-types of participants based on their emotional reactivity (see Table 1).

Finally, in order to assess the link between responsibility and variables of interest – i.e. emotional reactivity and emotional valence – we used binomial logistic regression. Variables of interest and potential confounders (socio-demographic variables, driver's status and the number of accidents in the last five years) were included in the multivariate binomial logistic regression model to predict responsibility.

3.) **Results**

Based on their reports, 415 (47%) participants were classified as responsible and 472 (53%) as not responsible. Among socio-demographic variables, only driver's status was significantly associated with responsibility (χ^2=4.6$_{(1)}$, p<0.05), indicating that professional drivers were less responsible than non-professional ones. Emotional valence had a trend effect (W=96390, p=0.077), suggesting that responsible drivers presented a more negative emotional state (M=6.24, Sd=2.2) than non-responsible ones (M=6.57, Sd=1.92). No other variables were associated with responsibility (see Table1).

We then conducted a cluster analysis on the four items of the emotional dimension of the MATHYS scale in order to highlight different emotional profiles of the drivers irrespective of their responsibility. Hierarchical cluster analysis using Euclidean distance with the Ward method revealed four distinctive profiles. A first profile included 54% of the drivers who demonstrated basic emotional reactivity (n=480, M=19.9, Sd=0.7). A second profile made up of 29% of the drivers with mild emotional hyper-reactivity (n=254, M=22.2, Sd=2.39). The third and fourth profiles included respectively the 11% of the drivers who exhibited emotional hyper-reactivity (n=96, M=28.7, Sd=3.3) and the 6% of the drivers who exhibited emotional hypo-reactivity (n=57, M=16.8, Sd=4.4). A chi-square test showed that responsibility was significantly associated with the emotional profile of drivers (χ^2=10.38$_{(3)}$, p<0.05). Fewer than 50% of the drivers in the normal (43%) and the mild hyper-reactivity

(48.4%) groups where classified as responsible for traffic accidents, while they accounted for respectively 52% in the hyper-reactivity group and 63% in the hypo-reactivity group (see Figure1).

Insert Figure1 about here

Finally, we assessed the link between emotional reactivity level and the risk of being responsible for a traffic accident. Emotional hypo-reactivity was significant both with univariate and multivariate regression. Results of univariate binomial regression showed that drivers who displayed emotional hypo-reactivity (less emotion, less intense) reported a 2.3-fold (95%CI[1.29, 4.02]) greater risk of being responsible for a traffic accident than those with basic emotional reactivity. Although non-significant, drivers with emotional hyper-reactivity (more emotion, more intense) had a 1.45-fold (95%CI[0.93, 2.24]) greater risk of being responsible for a traffic accident than those with basic emotional reactivity (see Table2). When emotional reactivity, socio-demographic variables, emotional valence and driver's status were simultaneously included in the model, emotional reactivity remained significant (χ^2=10.2, p<0.05) as well as driver's status (χ^2=4.9, p<0.05). Only the emotional hypo-reactivity group had a significant odds ratio (z=2.34, p<0.05) (see Figure2).

4.) **Discussion**

The main objective of this study was to assess to what extent emotional reactivity is a factor involved in responsibility for traffic accidents. The results showed that drivers' responsibility depends at least partially on their emotional status. Indeed, drivers with emotional hypo-reactivity, were more often responsible for crashes than those with basic emotional reactivity. Regarding emotional hyper-reactivity the pattern of results, although not significant, suggests a possible effect on responsibility for crashes. Overall, results suggest that emotional regulation may be part of an individual's coping style, while emotional dysregulation may impair functioning and be associated with psychiatric disorders (Henry et al., 2012) and risk behaviors,

We found that emotional hypo-reactivity predicted responsibility in traffic accidents. This result indicates that feeling emotion with less intensity leads to a modification of the abilities of individuals to adapt to their environment, making these abilities less efficient for a given

ongoing task. This result provides insight into which processes are involved in depressive patients and highlights the link between depression and the risk of being involved in traffic accident (Rapoport, Zagorski, Seitz, Herrmann, Molnar and Redelmeier, 2011). Indeed, anhedonia, one of the main symptoms of depression, focuses not only on the valence of emotions but also on emotional activation. Anhedonia is an inability to feel pleasure in normally pleasurable activities. The capacity of experience pleasure is decreased. .

Others studies have shown that emotion dysregulation has an impact on attention and behavior. Attentional deployment is one of the first emotion regulatory processes to appear (Rothbart et al., 1992). For example, emotional valence has an impact on attention; negative stimuli are associated with longer response times than positive stimuli (See for example Pratto and John, 1991, with an emotional stroop task). Moreover, negative affects are linked with risky and aggressive behaviors (Dula and Geller, 2003). In the context of driving, performances have been shown to be affected by the valence of the emotional content (Chan and Singhal, 2013). In the study by Chan and Singhal (2013) participants have to carry out a driving task in a simulator, in four different conditions. They have to drive on a 6.4 km-long circuit while seeing on billboards non-emotional words in one condition, positive emotional words in a second condition, negative emotional words in a third condition. Nothing was presented on billboards in the fourth (control) condition. The main result of this study showed that drivers exhibited lower mean speeds (the average velocity in km/h) when emotional words (negative and positive) disturbed them compared to a neutral context. Moreover, when words were positive, the slowing effect lasted longer (Chan and Singhal, 2013). Emotional distraction leads to the reorientation of attention away from the driving task which can disturb the decision-making process. Our study also shows that both valence and arousal can have an impact and should be included in studies focused on emotion. Indeed, the description of emotion should go beyond the simplistic mention of the type of emotion (anger, sadness, fear…). The conceptual act model (Barrett, 2006) defines emotion as a core affective system which consists of neurobiological states that can be described as pleasant or unpleasant with some degree of arousal (Barrett et al., 2007). The conscious experience is a single integral blend of two dimensions, valence and arousal (Russell, 2003).

The internal state of drivers is known to be a risk factor for distraction. For example, distraction seems to be a risk factor for road crashes (Wang et al., 1996; Wilson and Stimpson, 2010) and for the nature of errors made by drivers (Young et al., 2013). With regard to distraction, behavior has been associated with diversion of attention toward a competing activity (Lee et al, 2008). However, in another study concerning the impact of diverted attention, the authors considered that this definition excludes inattention due to driver states that may affect performance (bored, sleepy, fatigued, drunk, under the influence of illegal or medicinal drugs, emotionally upset) or due to cognitive workload induced by internal activities (e.g. daydreaming) (Bakiri et al., 2013). Therefore, our data support the hypothesis that emotional dysregulation can impair functioning and induce traffic accidents. Overall emotion dysregulation appears to be a potential source of internal distraction that may influence negatively safe driving. In terms of prevention campaigns, drivers are informed about the impact of behavior like drug and alcohol consumption (Penning et al., 2010) and driving speed (Aarts and van Schagen, 2006), but their emotional status is never targeted. The present findings obtained in the general population suggest that the public should be made aware of their emotional level of reactivity before driving. Like checking one's level of gasoline, doing an emotional auto-scan could become a reflex act before driving. This could be particularly useful for at-risk populations such as professional drivers involved in the carriage of goods or passengers by road.

Another issue concerns the link between high-level emotion and risk behavior as in people with borderline personality disorder (BPD), who are characterized by emotion dysregulation, impulsivity, identity disturbance, problematic interpersonal relationships, and suicidal/self-injurious behaviors, among others (APA, 2000). According to Lineham's model (1993), such people have heightened emotional sensitivity, inability to regulate intense emotional response and a slow return to emotional baseline. Crowell et al. (2009) also raise the hypothesis of a poor impulse control. Indeed, many people with BPD have risk behavior leading to both suicidal and non-suicidal self-injury increased by the combination of internalizing and externalizing psychopathology (Verona et al., 2004). One hypothesis is that risk behavior is an attempt at self-regulation of emotion. Our findings suggest that some drivers with emotional hyper-reactivity tend to exhibit more risk-taking behavior than drivers with normal emotional reactivity. Emotional reactivity has been linked with several

risk behaviors such as addictive behaviors, suicide attempts or sexual risk taking. In addition, they might constitute the basis on which to set up behavioral strategies with emotionally vulnerable populations such as those with borderline personality, patients with bipolar disorders, patients with attention deficit hyperactivity disorder (ADHD).

However, the present findings should be interpreted carefully owing to some limitations. More research is required on all types of persons involved in traffic accidents if the aim is to improve the safety of road users, in particular vulnerable road users such as pedestrians, cyclists and motorcyclists. Another limitation concerns the methodology used to collect the data. The participants were interviewed at the adult emergency hospital a certain time after their accident, which inevitably implies a memory bias whose impact is difficult to appreciate. It would be interesting to design a study using experience-sampling methodology (ESM) for detecting the propensity to be responsible for traffic accidents in association with emotional status. Indeed, ESM can capture rich information about changes that may not be detected by observer ratings (So et al., 2013).

Several avenues of research now require exploration. In terms of public health, there is a need to adopt prevention measures. At the clinical level, vigilance is needed with regard to patients presenting emotional disturbances such as hypomanic states, anxiety disorders and depression in order to limit the risks of being involved in accidents. Health professionals such as family doctors, psychiatrists and psychologists could be encouraged to inform patients about the personal hazards of driving while they are emotionally disturbed. Increasing awareness of the relationship between emotional instability and traffic accidents would promote the health and safety of public highway users.

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Figure1: Percentage of drivers responsible and non-responsible according to emotional reactivity profile

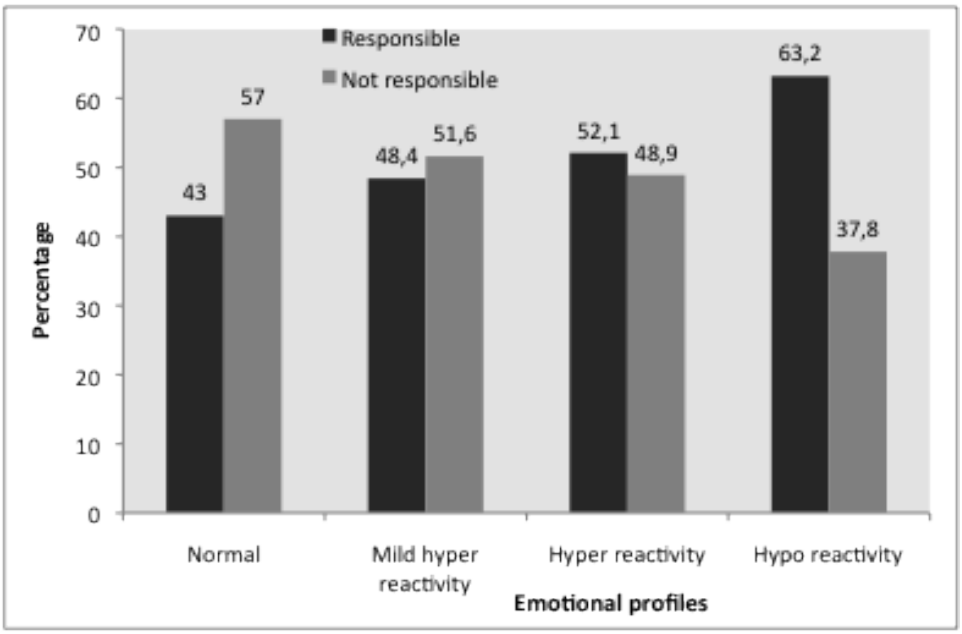

Figure2: Odds ratios for responsibility for traffic accidents, adjusted for sex, age, emotional status, driver's status, season and location

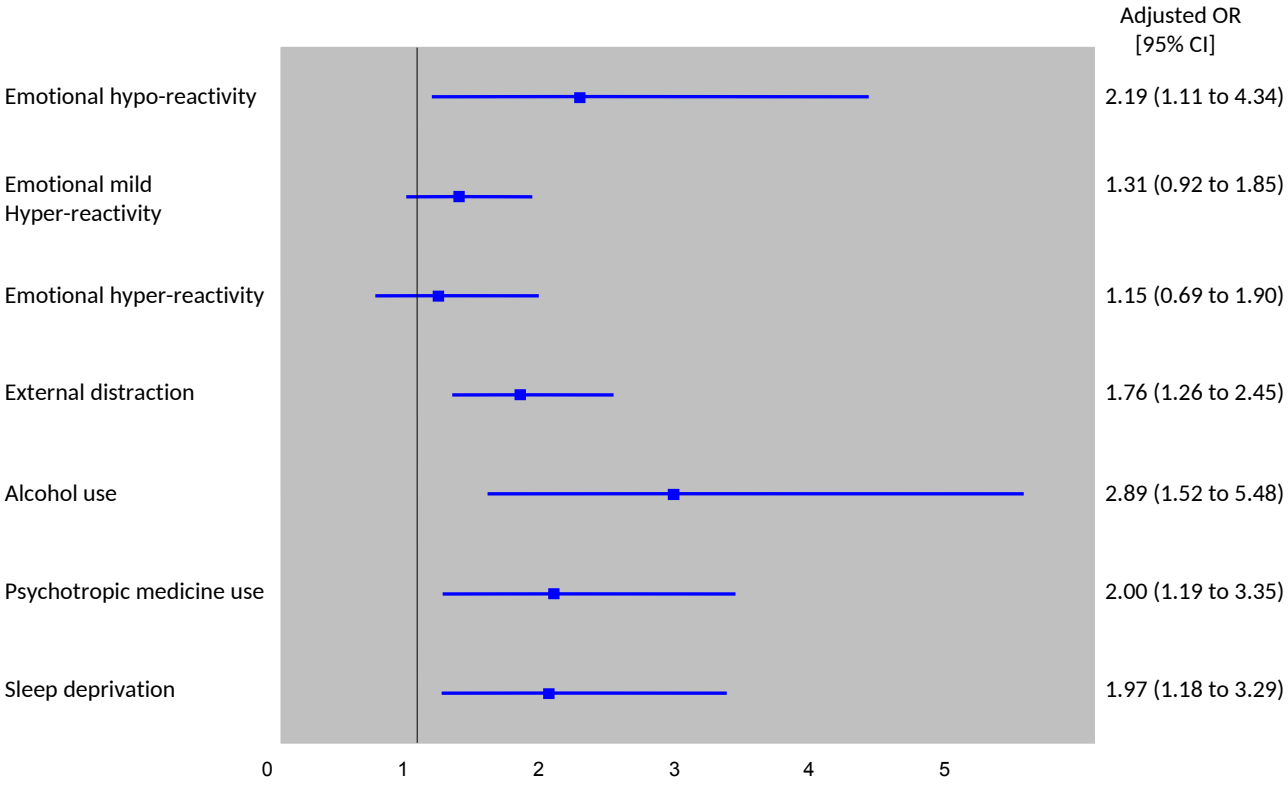

Table 1: Sample characteristics of drivers and responsibility for traffic accidents

	Responsible (*n*=415) *n* (%)	Not responsible (*n*=472) *n* (%)	Total participants (*n*=887)	*P*-value
Gender				NS
Male	252 (47.9)	274 (52.1)	526	
Female	163 (45.1)	198 (54.9)	361	
Age (years)				NS
18-24	112 (51.9)	104 (48.1)	216	
25-34	114 (47.3)	127 (52.7)	241	
35-44	064 (39.5)	098 (60.5)	162	
45-54	061 (45.9)	072 (54.1)	133	
≥55	064 (47.4)	071 (52.6)	135	
Socioeconomic category				NS
Worker/farmer	022 (51.2)	021 (48.8)	043	
Self-employed	024 (45.3)	029 (54.7)	053	
White collar	209 (45.3)	252 (54.7)	461	
Middle management	038 (46.3)	044 (53.7)	082	
Top management and professional occupation	021 (46.7)	024 (53.3)	045	
Retired/unemployed	041 (45.6)	049 (54.4)	090	
Student	060 (53.1)	053 (46.9)	113	
Driver's status				$<10^{-2}$
Not professional	362 (48.3)	387 (51.7)	749	
Professional	053 (38.4)	085 (61.6)	138	
Vehicle type				NS
Light vehicle	190 (43.9)	243 (56.1)	433	
Commercial vehicle	010 (52.6)	009 (47.4)	019	
Heavy goods vehicle	008 (66.7)	004 (33.3)	012	
Bicycle	090 (51.1)	086 (48.9)	176	
Scooter	049 (46.7)	056 (53.3)	105	
Motorbike	068 (47.9)	074 (52.1)	142	
Time of day				NS
05.00-10.59	169 (44.0)	215 (56.0)	384	
11.00-13.59	099 (48.5)	105 (51.5)	204	
14.00-19.59	109 (46.2)	127 (53.8)	236	
20.00-04.59	038 (60.3)	025 (39.7)	063	
Season				$<10^{-2}$
Summer	119 (50.2)	118 (49.8)	237	
Autumn	103 (45.6)	123 (54.4)	226	
Winter	043 (35.3)	079 (64.7)	122	
Spring	150 (49.7)	152 (50.3)	302	
Location				$<10^{-2}$
≥ 50,000 inhabitants	207 (43.4)	270 (56.6)	477	
< 50,000 inhabitants	208 (50.7)	202 (49.3)	410	
Mean emotional state (standard deviation)	6.4 (2.1)	6.7 (1.8)		NS

Table 2. Univariate analysis of driver responsibility for traffic accidents.

	Participants (%)	Responsible %	Odds ratio (95% CI)
Emotional reactivity			
Normal	480 (54.1)	42.9	Ref.
Mild hyper-reactivity	254 (28.6)	48.4	1.25 (0.92 to 1.70)
Hyper-reactivity	096 (10.8)	52.1	1.45 (0.93 to 2.24)
Hypo-reactivity	057 (06.5)	63.2	2.28 (1.29 to 4.02)
External distraction			
Yes	310 (35.0)	53.2	1.49 (1.13 to 1.96)
No	577 (65.0)	43.3	Ref
Alcohol use			
Yes	064 (07.2)	75.0	3.73 (2.08 to 6.67)
No	823 (92.8)	44.6	Ref.
Sleep deprivation			
Yes	092 (10.4)	65.2	2.32 (1.48 to 3.65)
No	795 (89.6)	44.7	Ref.
Psychotropic medicine use			
Yes	091 (10.3)	61.5	1.95 (1.25 to 3.04)
No	796 (89.7)	45.1	Ref.