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## Effect of alcohol and divided attention task on simulated driving performance of young drivers

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1 **Road Safety and Simulation**  
2 **International Conference**  
3 **RSS2013**

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5 **October 22-25, 2013**  
6 **Rome, Italy**  
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9 **EFFECT OF ALCOHOL AND DIVIDED ATTENTION TASK**  
10 **ON SIMULATED DRIVING PERFORMANCE OF YOUNG DRIVERS.**  
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**79 ABSTRACT**

80

81 The aim of this study is to evaluate driving impairment linked to divided attention task and  
82 alcohol and determinate whether it is higher for novice drivers compared to more experienced  
83 drivers. Sixteen novice drivers and sixteen experienced drivers participated in three experimental  
84 sessions corresponding to blood alcohol concentration (BAC) of 0.0 g/L, 0.2 g/L and 0.5 g/L.  
85 They performed a divided attention task (car-following task combined with a number parity  
86 identification task), and their results were compared to baselines obtained in reference single-  
87 tasks. Driving performance was evaluated by standard deviation of lateral position and minimum  
88 inter-vehicular distance. Response time and accuracy on additional task were also measured.  
89 Overall, ANOVA showed a driving impairment from BAC of 0.5 g/L with an increase of lateral  
90 position variability and a decrease of correct response percentage. In addition, novice drivers  
91 seem to be particularly disrupted by negative impact of alcohol because they adopt more risky  
92 behavior as to tailgate the vehicle in front of them. In divided attention task, driving impairment  
93 was found for all drivers. With respect to accuracy, information processing impairment was  
94 highlighted, notably in peripheral vision. Results are interpreted in terms of limited information  
95 processing capacity. Thus, the divided attention task used here provides a relevant method to  
96 isolate and identify effects of acute alcohol intoxication on cognitive functions and could be used  
97 in psychopharmacological research.

98

99 **Keywords:** alcohol; divided attention; driving experience; simulator

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101

**102 INTRODUCTION**

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104 Driving is a complex activity of dynamic processes control which requires accurate diagnosis of  
105 the situation and relevant decision-making. Drivers have to select relevant information in traffic  
106 in order to anticipate and react effectively to sudden events. Many factors can influence driver  
107 behaviour and lead to crashes.

108 Among them, alcohol is recognized as one major factor of driving impairment and researchers  
109 demonstrate a linear relationship between blood alcohol concentration (BAC) and crash risk  
110 notably for young drivers (Peck et al., 2008; Zador et al., 2000). Alcohol consumption impairs  
111 skills necessary to safe driving (Moskowitz and Fiorentino, 2000) and disrupts the information  
112 processing (Harrison and Fillmore, 2011; Fillmore, 2003). In psychopharmacological studies,  
113 driving performance is traditionally measured by standard deviation of lateral position (SDLP).  
114 After alcohol intake, studies indicate an increase of SDLP (Meskali et al., 2009; Rakauskas et al.,  
115 2008), a delay in reaction time to sudden events and an impairment of vigilance, visual and  
116 divided attention (Koelaga, 1995).

117 Otherwise, the lack of experience is also recognized as a main factor of crash. Indeed, young  
118 drivers are widely overrepresented in road accidents so that, in France, it is the first cause of  
119 death among drivers under 25 (ONISR, 2011). There is a wide field of research showing that  
120 skills necessary to safe driving improve significantly with experience (Mc Cartt et al, 2009;  
121 Mayhew and Simpson, 1995). Ability to control vehicle is one of the first skills acquired by  
122 training and it is mastered in few hours (Hall and West, 1996), perceptive and cognitive abilities  
123 are then developed. They are slower processes which include attentional allocation (Crundall and  
124 Underwood, 1998), matching between task demands and driving skills (Brown and Groeger,

125 1988) and contribute to driver's potential ability to detect hazards. These crucial skills improve  
126 with experience (Deery, 1999; Underwood, 2007).

127 Another factor of crash is driver distraction (Klauer et al, 2006) which can occurs when driver  
128 attention is captured intentionally or not by a secondary task unrelated to driving task (Regan,  
129 2011). Actually, 19% of drivers are engaged in an additional task like speaking, eating, drinking,  
130 smoking or using the mobile phone while driving (Gras et al., 2010). Performing an additional  
131 task is known to reduce driving performance and increase reaction time (Andersen et al., 2011;  
132 Cantin et al., 2009; Bian et al., 2000). For example, using a mobile phone during a car following  
133 task increases the mental load which results in a delay in brake reaction time (Lamble et al.,  
134 1999) and in the reaction time to headway changes (Brookhuis and De Waard, 1994). Driver's  
135 distraction by an additional visual task leads to an increase of mistake production (Young and  
136 Salmon, 2012) and when novice driver is texting message, he spends less time to look the driving  
137 scene (Hosking et al., 2009). Performance impairment linked to an additional task, often  
138 measured in simulated environment, is confirmed by study carried out on real-environment  
139 (Blanco et al., 2006) and can be interpreted in terms of limited information processing capacity  
140 (Kahneman, 1973). When driver performs simultaneously several tasks, he is placed in divided  
141 attention situation and he has to divide adequately its attentional resources between driving and  
142 additional task. Thereby, mental load related to driving task increases when driver has to divide  
143 his attentional resources between two tasks (Lemercier and Cellier, 2008). Recently, researchers  
144 showed that the impairment linked to divided attention is even more pronounced when driver is  
145 under the influence of alcohol (Harrisson and Fillmore, 2011).

146 Alcohol, lack of experience and divided attention are thus recognized as three factors  
147 contributing to road-accident. Many studies are focused on the effects of each of these factors,  
148 but few have investigated their possible interaction. The aim of the present research is to evaluate  
149 driving-impairment linked to divided attention and alcohol and to determinate if this impairment  
150 is higher for novice drivers compared to more experienced drivers.

151

## 152 **METHOD**

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### 154 **Participants**

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156 32 students separated in two groups depending on driving experience took part in this study. The  
157 first group consisted of 16 novice drivers (7 female and 9 male) aged 18 who had less than 2  
158 months of driving experience and drove less than 5000 km. The second group consisted of 16  
159 experienced drivers (8 female and 8 male) aged 21 who had three years of driving experience  
160 and drove more than 20,000 km. All participants obtained their driver's license at 18 years. This  
161 two groups correspond to the beginning and end of probationary license in France.

162 Participants underwent a medical examination in order to confirm their good physical condition,  
163 the absence of sleep disorder and of any treatment at the time of inclusion and during the  
164 previous 15 days. Volunteers completed questionnaire that provided demographic information  
165 and drinking habits in order to control they did not have a substance abuse disorder. Only social  
166 drinkers, defined as individuals with alcohol moderate consumption (about two alcohol glasses,  
167 not every day) chiefly in a social context, are included in this experiment.

168

169 To avoid any learning effect, participants carried out training before the experimental sessions.  
170 They provided written informed consent and received 120 euros for their participation. The  
171 experimental protocol was approved by local Ethics Committee.

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### 173 **Experimental Design**

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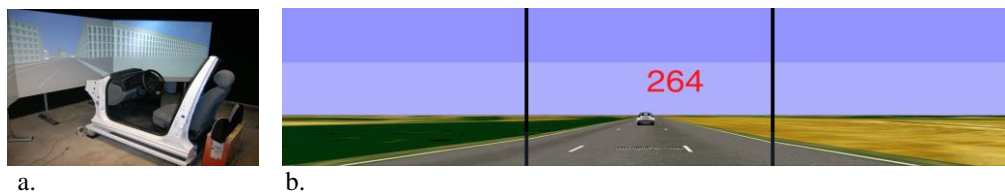
175 The driving experiment was carried-out on the SIM<sup>2</sup>-IFSTTAR fixed base driving simulator  
176 equipped with an ARCHISISM object database (Espie et al., 2005) (See Figure 1a). Driving  
177 simulator is a relevant tool in our study because there is a large degree of similarity in the  
178 relationship between the BAC levels and driving impairment observed in driving simulator and  
179 on real driving (test-track) (Helland et al., 2013).

180 Three experimental sessions were carried-out according to a single-blind, balanced, cross-over  
181 design. Before each session, participant had a drink (vodka and orange juice) in order to obtain a  
182 BAC of 0 (placebo), 0.2 or 0.5 g/L. BAC was measured with a breathalyzer (SD-400 DJP/LION)  
183 15 min after alcohol intake, and then each 10 min until the desired BAC was obtained. All  
184 volunteers participated in the three sessions held at intervals of at least one day.

185 Each session includes three tasks and had a total duration of 30 min. The order of presentation of  
186 the two single tasks was counterbalanced between each experimental session. Single task of car-  
187 following was performed in order to evaluate baseline of driving performance. Drivers had to  
188 follow a lead vehicle while keeping a constant distance with this vehicle. In order to prevent  
189 learning effect the lead vehicle speed varied with sixteen accelerations and sixteen decelerations  
190 either with high or low amplitude. The driver was placed in the middle of three-lane road, so that  
191 the visual environment was perfectly symmetrical. Single task of number parity identification  
192 was carried-out, in order to ensure that its cognitive cost is similar for experienced and novice  
193 drivers. Number parity identification task required to identify even and odd numbers and to  
194 activate the right control of the steering wheel if the target was even or the left control if the  
195 target was odd. A three-figure number appeared in 1.5 seconds to 2.5 seconds intervals with a  
196 duration of 400 milliseconds, either in a central or peripheral (left and right) vision. Then,  
197 volunteers performed a divided attention task which implies performing simultaneously a car-  
198 following task while identifying parity numbers which can appear on central or peripheral vision  
199 (left or right) (See Figure 1b). The interference related to the divided attention task was computed  
200 and compared with baseline measures obtained in single-tasks.

201 The main driving task has been specifically chosen on the basis of previous study showing that  
202 car-following situation involve behavioral impairment in case of alcohol intoxication (Meskali et  
203 al., 2009) and the secondary-task has been chosen apart from driving context in order to avoid  
204 possible learning effect linked to driving experience. In addition, while driving most of  
205 information used are visual information (Sivak, 1996) and the divided attention task use the same  
206 perceptual channel (visual) for the two tasks. According to multiple resources theory of Wickens  
207 (1984, 2002), it is a good way to highlight interference between two tasks.

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Figure 1 a. Driving simulator; b. Visual scenario of divided attention task

## 213 **Measures**

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215 Driving performance was evaluated through lateral and longitudinal vehicle control. Lateral  
216 control was measured by the standard deviation of the lateral position (SDLP) which was defined  
217 as an indicator of the degree of adjustment that a driver implements to maintain a desired  
218 position within the lane (Harrison and Fillmore, 2011). Thus, SDLP reflects keeping-lane skills.  
219 Many research established that SDLP is a valid and sensitive indicator of impaired behavior  
220 (Harrison and Fillmore, 2005; Rakauskas et al., 2008; Shinar et al., 2005) and an increase of  
221 SDLP indicates an impairment of vehicle control ability (Harrison and Fillmore, 2011).  
222 Longitudinal control was measured by the minimum inter-vehicular distance (min IVD) e.g the  
223 minimum distance adopted between the rear of the lead vehicle and the front of the following  
224 vehicle.

225 Additional task performance was measured by reaction time (RT) and percentage of correct  
226 response (CR).

227

## 228 **Data Analyses**

229

230 Results from the divided attention task were compared to results obtained in the reference tasks  
231 (single task of car-following and single task of number parity identification).

232 Firstly, the effects of BAC, task and driving experience on driving performance were analyzed  
233 by 2 (driving experience) \* 3 (BAC) \* 2 (task) repeated measure analyses of variance (ANOVA).  
234 Secondly the effects of BAC, task, number location and driving experience on response-time and  
235 accuracy of number parity identification were analyzed by a 2 (driving experience) \* 3 (BAC) \*  
236 2 (task) \* 3 (number location) ANOVA. Statistical analyses were performed using Statistica  
237 software. The data were tested for significance threshold of  $p < 0.05$ . Bonferroni post-hoc tests  
238 were subsequently used for pairwise comparisons.

239

## 240 **RESULTS**

241

### 242 **Driving Performance**

243

#### 244 Standard Deviation of Lateral Position

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246 As expected, ANOVA showed a significant main effect of driving experience ( $F(1, 30) = 3.92, p$   
247  $< 0.05$ ). SDLP was higher for novice drivers than for experienced drivers (respectively,  $M =$   
248  $14.72$  cm;  $SD = 4.2$  and  $M = 12.71$  cm;  $SD = 3.4$ ).

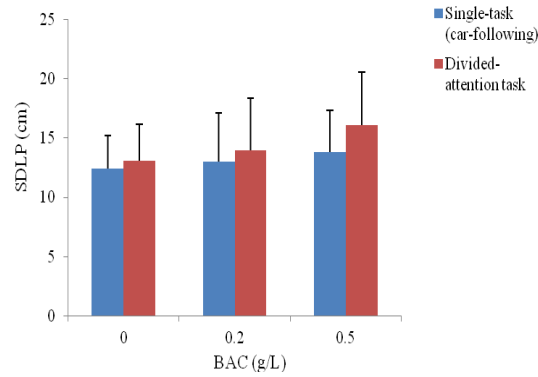
249 A significant main effect of task was also highlighted ( $F(1, 30) = 13.64, p < 0.001$ ). Overall,  
250 SDLP was higher in divided attention task compared to single task of car-following  
251 (respectively,  $M = 14.4$  cm;  $SD = 3.8$  and  $M = 13.07$  cm;  $SD = 3.3$ ).

252 In accordance with our assumption, ANOVA revealed a significant main effect of BAC ( $F(2,$   
253  $60) = 9.5, p < 0.001$ ). Drivers' SDLP with a BAC of 0.5 g/L ( $M = 14.95$  cm;  $SD = 4$ ) was higher  
254 than those with a BAC of 0.2 g/L ( $M = 13.47$  cm;  $SD = 4$ ) and 0.0 g/L ( $M = 12.7$  cm;  $SD = 2.8$ ).  
255 Any significant difference was found between placebo and BAC of 0.2 g/L.

256 A trend toward significant interaction between BAC and task was found ( $F(2, 60) = 2.44, p =$   
257  $0.09$ ). Pairwise comparisons showed that an increase of SDLP in divided attention task compared  
258 to single-task was only significant with a BAC of 0.5 g/L (respectively,  $M = 16.07$  cm;  $SD = 4.5$

259 and  $M = 13.83$  cm;  $SD = 3.5$ ). When drivers were in divided attention task with a BAC of 0.5  
 260 g/L, their SDLP was significantly higher than in all others conditions of BAC and task (see  
 261 Figure 2).

262 No significant interaction was found between driving experience and BAC on SDLP ( $F(2, 60) =$   
 263  $1.68$ ,  $p = 0.19$ ), neither between driving experience and task ( $F(1, 30) = 0.48$ ,  $p = 0.49$ ).  
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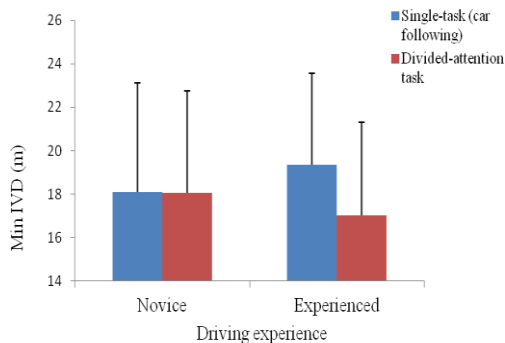


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 267 Figure 2 Standard Deviation of Lateral Position depending on BAC and Task  
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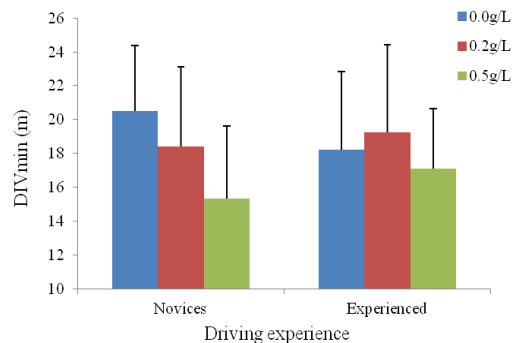
### 269 Minimum Inter-Vehicular Distance

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 271 A significant main effect of task was demonstrated ( $F(1, 30) = 7.38$ ,  $p < 0.05$ ). Overall, min IVD  
 272 was shorter in divided attention task compared to single-task of car-following (respectively,  $M =$   
 273  $17.55$  m;  $SD = 4.5$  and  $M = 18.73$  m;  $SD = 4.6$ ). An interaction between task and driving  
 274 experience ( $F(1, 30) = 6.9$ ,  $p < 0.05$ ) showed that a decrease of min IVD in divided attention  
 275 task was only significant for experienced drivers (See Figure 3).

276 ANOVA revealed a significant main effect of BAC on min IVD ( $F(2, 60) = 16.36$ ,  $p < 0.001$ ).  
 277 Overall, drivers' min IVD with a BAC of 0.5 g/L ( $M = 16.22$  m;  $SD = 4.4$ ) were shorter than  
 278 those of drivers with a BAC of 0.2 g/L ( $M = 18.85$  m;  $SD = 4.4$ ) and with placebo ( $M = 19.35$  m;  
 279  $SD = 4.4$ ). Any significant difference was found between placebo and BAC of 0.2 g/L. In  
 280 accordance with our assumption, a significant interaction between BAC and driving experience  
 281 ( $F(2, 60) = 6.6$ ,  $p < 0.01$ ) specified that the decrease of minimum IVD with alcohol was only  
 282 significant for novice drivers (See Figure 4).



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 293 Figure 3 Minimum Inter-vehicular Distance  
 294 depending on Task and Driving Experience  
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## 296 Additional Task Performance

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### 298 Response-time

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300 As expected, a significant main effect of driving experience was found ( $F(1, 30) = 4.43, p < .05$ ). Overall, novice drivers had slower response-time compared to experienced drivers  
 301 (.05). Overall, novice drivers had slower response-time compared to experienced drivers  
 302 (respectively,  $M = 0.88$  s;  $SD = 0.12$  and  $M = 0.84$  s;  $SD = 0.1$ ).

303 ANOVA showed a significant main effect of task ( $F(1, 30) = 11.01, p < .005$ ). Overall, drivers  
 304 had slower response-time in single task of number identification compared to divided attention  
 305 task (respectively,  $M = 0.87$  s;  $SD = 0.1$  and  $M = 0.85$  s;  $SD = 0.10$ ).

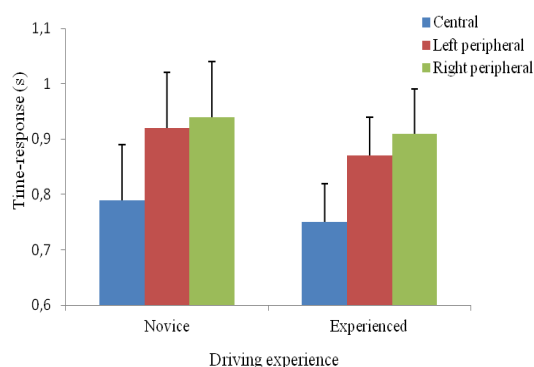
306 A significant main effect of number location was also found ( $F(2, 60) = 629.54, p < .001$ ).  
 307 Drivers had slower response time when number appeared in the peripheral vision –right ( $M =$   
 308  $0.93$  s;  $SD = 0.09$ ) and left ( $M = 0.90$  s;  $SD = 0.09$ ) - compared to central vision ( $M = 0.77$  s;  $SD$   
 309  $= 0.08$ ). Response time difference between right and left peripheral identification was significant.

310 A trend toward significant interaction between number location and driving experience was  
 311 obtained ( $F(2, 60) = 2.49, p = 0.09$ ) showing that only experienced drivers response time was  
 312 slower when number appeared in right peripheral compared to left peripheral vision (see Figure  
 313 5).

314 No significant main effect of alcohol was found on response time, neither interactive effect  
 315 between BAC and driving experience ( $F(2, 60) = 0.86, p = .43$ ), BAC and task ( $F(2, 60) = 0.21,$   
 316  $p = .81$ ), BAC and number location ( $F(4, 120) = 0.52, p = .72$ ).

317

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319

320 Figure 5 Reaction time depending on Driving experience and Number location

321

### 322 Accuracy

323

324 In accordance with our assumption, ANOVA revealed a significant main effect of BAC ( $F(2,$   
 325  $60) = 4.03, p < .05$ ). Correct response percentage was lower for drivers with a BAC of 0.5 g/L  
 326 ( $M = 86.8$  %;  $SD = 8.6$ ) than those of drivers with a BAC of 0.2 g/L ( $M = 89$  %;  $SD = 9$ ) and 0.0  
 327 g/L ( $M = 89.6$  %;  $SD = 7.4$ ).

328 A significant main effect of number location was found ( $F(2, 60) = 81.27, p < .001$ ). Pairwise  
 329 comparisons indicated that correct response percentage was lower when number appeared in  
 330 peripheral vision, either the right ( $M = 87.2$  %;  $SD = 9$ ) or left side ( $M = 81.7$  %;  $SD = 11.8$ ),  
 331 compared to when number appeared in central vision ( $M = 96.1$  %;  $SD = 4.3$ ). Moreover,

332 percentage of correct response in right peripheral vision was significantly lower than those in left  
333 peripheral vision.

334 A significant interaction between BAC and number location ( $F(4, 120) = 3.1, p < .05$ ) specified  
335 that decrement of correct response percentage with highest BAC was only significant when the  
336 number appeared in peripheral vision (right and left side). In addition, a significant decrease of  
337 correct response percentage was found with a BAC of 0.5 g/L compared to a BAC of 0.2 g/L  
338 only when number appeared in the right peripheral vision (see Figure 6).

339 ANOVA also revealed a significant main effect of the task, ( $F(1, 30) = 28.88, p < .001$ ) showing  
340 a decrease of correct response percentage in divided attention task compared to baseline  
341 performance in single-task of number parity identification (respectively,  $M = 86.2\%$ ;  $SD = 9.7$   
342 and  $M = 90.8\%$ ;  $SD = 7$ ).

343 A significant interaction between task and number location, ( $F(2, 60) = 21.76, p < .001$ ) pointed  
344 out that this decrease of correct response percentage in divided attention task was only  
345 significant when number appeared in right peripheral vision (See Figure 7).

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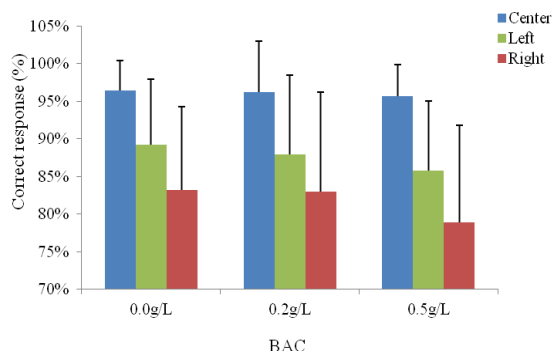
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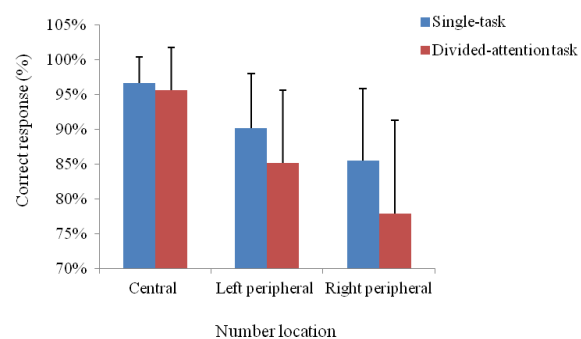
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357 Figure 6 Correct responses depending on  
358 BAC and Number location.



359 Figure 7 Correct responses depending on  
360 Task and Number location

## 359 DISCUSSION

360

361 In the present study, the relationships between BAC, divided attention and driving experience on  
362 simulated driving performance was investigated. The hypothesis was that the combination of  
363 alcohol and divided attention task would interact to impair driving performance, especially for  
364 novice drivers.

365

### 366 Alcohol effects

367

368 Analyses revealed that alcohol consumption impaired lateral and longitudinal control from BAC  
369 of 0.5 g/L. With respect to lateral control measured by SDLP, findings are consistent with those  
370 of previous studies in which a dose-response relationship between BAC levels and SDLP was  
371 demonstrated (Helland et al., 2013; Harrison and Fillmore, 2011; Meskali et al., 2009).  
372 Therefore, our data confirm that SDLP is a valid and sensitive indicator of driving impairment  
373 related to alcohol consumption. Overall, alcohol impairs lateral control independent of driving  
374 experience. It seems to be worthwhile to compare this result with those found by Meskali et al.  
375 (2011) because both studies used the same driving simulator and car-following task. In Meskali  
376 et al (2011), SDLP increase was only found significant with a BAC of 0.8 g/L, but subjects were  
377 experienced drivers with a mean age higher than our participants. This might suggest that lateral

378 control impairment appeared earlier for young drivers, as low as 0.5 g/L, but this hypothesis has  
379 yet not been tested statistically. With respect to longitudinal control measured by min IVD, only  
380 novice drivers adopt shorter inter-vehicular distance with BAC of 0.5 g/L e.g. alcohol impairs  
381 the longitudinal control ability of novice drivers but not that of experienced drivers. Thus, Min  
382 IVD is a relevant parameter to investigate specifically novice driver's skills and differentiate  
383 them from experienced drivers.

384 With respect to additional task performance, cognitive processing accuracy was impaired from  
385 BAC of 0.5 g/L, but not response time. This differential effect of alcohol depending on  
386 parameters measured has been explained by Schweizer and Vogel-Sprott (2008) which showed  
387 that cognitive processing speed tends to develop acute alcohol tolerance, but not accuracy.  
388 Regarding accuracy, alcohol-impairment occurred only when number appeared in peripheral  
389 vision. This result replicates the common effect of tunnel vision induced by alcohol, as suggested  
390 by driver's inability to disengage their attention from central visual field toward peripheral visual  
391 field (Do Canto-Pereira, 2007).

392 In spite of dose-response effect, any significant driving impairment related to the low dose of  
393 alcohol (BAC of 0.2 g/L) on performance was found. Otherwise, some epidemiological studies  
394 indicated that the crash severity increases as low as 0.1 g/L (Phillips and Brewer, 2011) and fatal  
395 crash risk is twice for a BAC of 0.2 g/L compared to BAC of 0.0 g/L, especially for young  
396 novice drivers (Peck et al., 2008). Two hypotheses could explain this result. Firstly, it might  
397 suggest that driving impairment induced by alcohol occurs with a BAC superior to 0.2 g/L as in  
398 others studies which indicate driving impairment only from 0.3 g/L (Schnabel et al, 2010).  
399 Thereby, this research contributes to precise the minimum level of BAC that impairs driving  
400 skills. Indeed, the limit of BAC for safety driving could be situated between 0.2 g/L and 0.3 g/L.  
401 Moreover, some countries have reduced the tolerated BAC at 0.2 g/L for specific population as  
402 novice and professional drivers and they record a decrease of crash number (Andreuccetti, 2011;  
403 Dupont et al, 2000). Secondly, another explanation concerns our task characteristics. In this  
404 study, driving scenario is relatively easy and contains only a straight road. In the extent that  
405 novice drivers are already in difficulty in complex situation without alcohol (Damn, 2011) and  
406 that alcohol particularly impairs complex task (Schnabel et al, 2010) it might be that a more  
407 complex task could highlight driving impairment of novice drivers with low doses of alcohol.  
408 Thus, future research should include more complex situations to specify these results.

409

#### 410 **Divided attention task effects**

411

412 Performance impairment was observed in divided attention task compared to reference single-  
413 task, that is car-following task or number identification task. Overall, driving performance  
414 (SDLP) and accuracy (CR) on additional task were impaired in divided attention task whatever  
415 driving experience. This result confirmed that performing an additional task while driving leads  
416 to a driving-impairment and disrupts the information processing. Difficulties observed in divided  
417 attention task can be explained by the limited information processing capacity. Indeed, the  
418 amount of attentional resources mobilized in divided attention task increases compared to each  
419 task alone and can exceed the amount of available resources (Kahneman, 1973).

420 With respect to longitudinal control, only min IVD of experienced drivers decrease in divided  
421 attention task compared to single task of car-following. Novice drivers' min IVD also decrease  
422 in divided attention task compared to baseline measure obtained in single task of car-following  
423 but difference are not significant certainly due to high heterogeneity of performance. In addition,

424 our participants are exclusively students' drivers which can reduce the difference between the  
425 two groups. It is actually well recognized that students drivers with high educational background  
426 are less involved in crash than general population at the same age (Murray, 1998).  
427 Regarding additional task performance, drivers had a lower correct response percentage in  
428 divided attention task compared to single-task of number parity identification only when number  
429 appeared in right peripheral vision. Response time was also impaired in right peripheral vision  
430 compared to left peripheral vision whatever the task. These results highlight different  
431 information processing depending on stimuli locations, and notably depending on peripheral side  
432 of vision. Response time difference depending on peripheral side was only found for experienced  
433 drivers suggesting that it takes place gradually with driving experience. Indeed, when the task is  
434 more demanding, as in divided attention task or when drivers are novice, gazes are focused on  
435 central visual field (Lemercier and Cellier, 2008; Williams, 1995).  
436 Surprisingly, subject response times are slower in single task of number parity identification task  
437 compared to divided attention task. Noted that number identification task responses are given  
438 with vehicle commands situated near of steering-wheel and that different hand position was  
439 observed depending on task. Indeed, in the single task of number parity identification,  
440 participants' hand position was variable whereas in divided attention task, their hands do not  
441 leave the steering wheel. Hand position in space may be is a relevant index of load related to the  
442 task demands and it seems to be necessary to control this factor in future research.

443

#### 444 **Driving experience effects**

445

446 Finally, results revealed that SDLP of novice drivers was higher than those of experienced  
447 drivers, which reflects a poorer lateral vehicle control. This result confirms the assumption that  
448 driving skills of novice drivers are lower than those of experienced drivers and is consistent with  
449 previous studies showing that experienced drivers exhibited an active control of their lateral  
450 position during urban scenario, contrary to novice drivers (Damn et al., 2011). In a similar way,  
451 novices' response times on additional task were slower than those of experienced driver which  
452 can be explained by involvement of different cognitive processes depending on driving  
453 experience. Indeed, the main task of car-following involved controlled processes for novice  
454 drivers, while these processes become automatic with experience. As a consequence, this task  
455 mobilized the quasi totality of attentional resources for novice drivers, and, few resources are  
456 available to process an additional task.

457

#### 458 **CONCLUSIONS**

459

460 To sum up, results classically showed that alcohol, divided attention task and lack of experience  
461 were independently related to driving impairment. In addition, our hypothesis is also confirmed:  
462 alcohol and driving experience interact to lead to a higher driving impairment for young novice  
463 drivers than for young experienced drivers. It is particularly interesting because the bound used  
464 to differentiate novice and experienced drivers was very thin. Indeed, only three years of driving  
465 experience and age separated novice and experienced drivers. As a result, this research  
466 contributes to improve knowledge on specific probationary period applied in France. In addition,  
467 the divided attention task used here provides a relevant method to isolate and identify effects of  
468 acute alcohol intoxication on cognitive functions and could be used in psychopharmacological  
469 research.

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