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Alcohol and Young Drivers: Subjective Tension, Alertness, And Performance

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Abstract. Assuming that, during monotonous driving, performance should be impaired with alcohol at a moment of low alertness, the main hypothesis of this work was that this impairment would be significant greater for Young Novice Drivers (YND) than for Young Experienced Drivers (YED). Sixteen YND (18 years, two months of driving) and fifteen YED (21 years, 3 years of driving) participated in three simulated driving sessions in which BACs were randomly assigned (0.0, 0.2 and 0.5 g/l). Every session took place between 2 and 4 pm, around one hour after the drink. The circuit represented a typical highway road, the task was to drive during 45 min and to maintain a steady speed (110 km/h) and a stable position on the lane. After each driving session participants estimated their workload (NASA-TLX) and their subjective alertness and tension (Thayer checklist). Results indicated a significant effect of alcohol and duration of driving on subjective evaluations and objective performance. Workload thus increased with 0.5 g/l, standard deviation of lateral positon of the vehicle (SDLP) is degraded from 0.2 g/l and increased with the duration of the driving task, and standard deviation of speed increased with 0.5 g/l and with the duration of the task. YND' subjective estimation of frustration were higher than YED's ones but did not significantly vary as a function of the level of alcohol. Conversely YED' estimation of frustration increased as a function of alcohol and their SDLP decreased at the end of the circuit, notably with 0.5 g/l.

Key words: alcohol, driving, workload, young drivers, performance

1. Introduction

Firstly, Young Novice Drivers (YND) have a high risk of accidents and their crashes are more numerous during the first year of driving (Maycock & Forsyth, 1997). Studies thus demonstrated that skills necessary for safe driving improve significantly with experience. Secondly, YND are also over represented in crashes linked to long period of drive or night driving (Vlakveld, 2004; Williams, 2003) and it is well known that the major part of sleep (or fatigue)-related accidents takes place during the early morning hours (2:00–6:00 a.m.) and during the afternoon period (1:00–4:00 p.m.) (Garbarino, Nobili, Beelke et al. 2001; Pack, Pack, Rodgman et al. 1995) corresponding to the two periods of physiological decrease of alertness. Thirdly, a monotonous road environment with low (or no) traffic density can also influence the level of alertness and, in these conditions, the first effects of fatigue and drowsiness can rapidly occur (after 15 to 30 min) (Dunn & Williamson, 2012). In fact, a long duration of driving in poor environment increases the workload, which in a first part increases the alertness and improves the performance, however after an optimum the increase of alertness is linked to a decrease of performance (see Figure 1). Finally, YND aged under 21 with BAC of 0.5g/l have a crash risk multiplied by two compared to drivers aged over 21 (Peck et al. 2008).

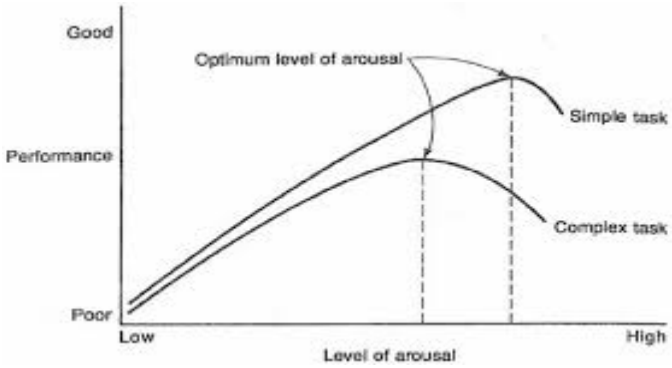

Figure 1. Relations between level of arousal and performance.

The objective of the current work is thus to evaluate subjective estimation of workload and alertness, but also objective performance of young drivers depending on Blood Alcohol Concentration (BAC) and driving experience. The main hypothesis is that during a long monotonous driving task realized at the time of low alertness, e.g. post prandial period, (1:00–4:00 p.m.), performance will be impaired with BAC increased. This impairment could appear significantly earlier and be more pronounced for YND than for Young Experienced Drivers (YED).

2. Experimental protocol

An experiment was carried out on a static driving simulator. Sixteen Young Novice Drivers (YND: 18 years, less than two months of driving license) and fifteen Young Experienced Drivers (YED: 21 years, 3 years of driving license, e.g. end of the probationary period in France) were invited to participate in three simulated driving sessions separated by a minimum of 24 hours in which BACs were randomly manipulated (0.0, 0.2 and 0.5 g/l). Every experimental session was between 1:45 and 3:45 pm during postprandial period, around one hour after the drink. The task consisted to drive on a circuit representing typical highway road during 45 min and to maintain a steady speed (110 km/h) and a stable position on the right lane. After each driving session participants estimated their workload (NASA-TLX questionnaire) and their subjective alertness and tension (Thayer checklist). Driving performance was analyzed for steps of 5 min.

Subjective evaluation and driving performance were submitted to ANOVAs, and in case of significance ($p < .05$) to Bonferroni post hoc tests. Only significant results were presented here.

3. Results

Thayer scale results only showed that all the participants were less alertness after than before the driving task. Results of the NASA-TLX indicated that placebo session produced lower estimation of time pressure, frustration and effort than 0.5 g/l session. Driving performance was also estimated worse with alcohol (0.2 and 0.5 g/l sessions). Only frustration dimension showed a significant effect of group with higher estimations for YND than for YED. Moreover YND estimations did not vary as a function of sessions, conversely frustration of YED was higher with 0.2 and 0.5 g/l than with placebo (Table1).

Table1. Subjective estimations of frustration as a function of group and level of alcohol.

	YND	YED
placebo	14.25 (3.42)	9.1875 (4.34)
0,2 g/l	13.81 (2.97)	12.93 (3.23)
0,5g/l	15.62 (2.91)	13.75 (3.04)
Total	14.25 (3.41)	11.96 (4.04)

Standard deviations of speed (SDspeed) were lower with placebo than with 0.5 g/l and increased from 25-30 min of driving. Analysis also showed that Standard Deviation of Lateral Position (SDLP) of the vehicles increased from placebo to 0.2 g/l and from 0.2 to 0.5 g/l and tended to increase after 20 min of driving. YED' SDLP were also lower after 40-45 min than after 25-30 min of driving, this is particularly evident with 0.5 g/l (Figure 2).

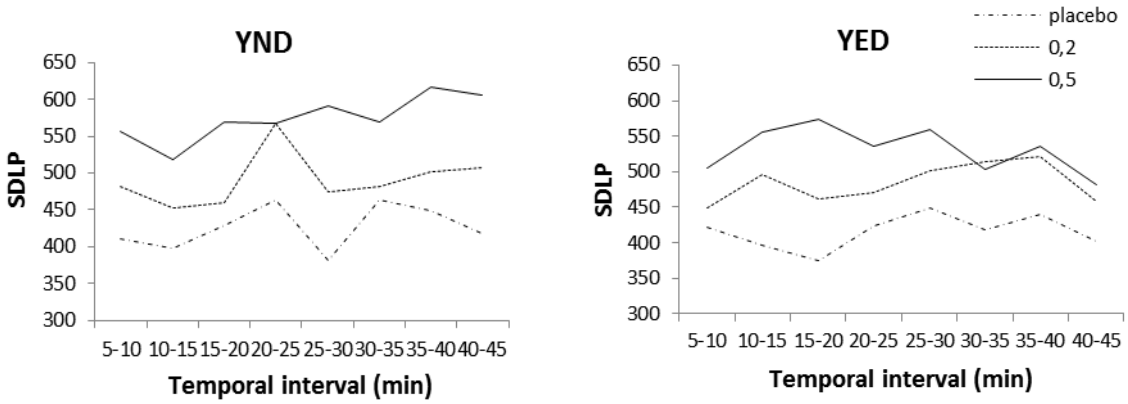

Figure 2. Mean SDLP as a function of group, level of alcohol and duration of driving.

4. Discussion and Conclusion

Subjective data obtained after driving show that workload is estimated higher with 0.5 g/l than without alcohol and that young drivers, whatever their experience, estimated their performance degraded as a function of the alcohol level, results confirmed by objective performance. Thus, the stability of the lateral control (SDLP) and of the longitudinal control of the vehicle (SDspeed) are degraded with alcohol. Young drivers have therefore a good appreciation of their performance under the influence of alcohol.

SDLP and SDspeed also increase after around 20 to 25 min of driving which could correspond to the first symptoms of fatigue (Dunn and Williamson, 2012). The degradation of lateral and longitudinal control of the trajectory would thus be a cue of vigilance decrease, amplified by the duration of driving.

Concerning driving experience, results are less clear but indicate that YED are more efficient than YND to estimate their level of frustration under alcohol. Moreover, the impairment of their objective performance is attenuated at the end of the drive, notably with 0.5 g/l. Their higher level of driving experience, comparatively to YED, could thus help them to implement compensatory mechanism to the deleterious effect of alcohol.

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