Effects of alcohol on drivers' perceptual ability and attention to concentration

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Abstract

The study explored the variation of the drivers' perceptual ability and attention concentration ability on condition of different Blood Alcohol Concentration (for short BAC). Through the method of own experimental control, we selected 34 male drivers who were from university, holding a C license, and had some driving experience. Every participant was requested to join in test of speed perception, depth perception and attention concentration ability on condition of different BAC(0, 20, 50, 80, 100mg/100ml). All the data we collected were analyzed by repeated measure ANOVA. Results indicated that no significant difference among the five sets of data was found for drivers' velocity estimation ability. Depth perception was significantly influenced by alcohol, especially when the BAC reached 50mg / 100ml or more, the drivers' depth perception error value was significantly higher than that of low alcohol concentration. When the BAC reached 50mg/100ml, the concentration time has changed significantly. Particularly, when BAC was 80mg/100ml or in the state of drunk driving, drivers' attention concentration ability decreased obviously.

Keywords: Blood Alcohol Concentration (BAC), drivers, perceptual ability, attention to concentration

1. Introduction

China's road transport business is developing rapidly, at the same time, the incidence of traffic accidents also showed a clear upward trend. The "Road Safety Global Status Report 2015" which released by World Health Organization (WHO) shows that the world has 1.25 million people died in traffic accidents in 2013, on average every 25 seconds one person died due to a traffic accident. According to the current trend, by 2030, the number of deaths worldwide due to road traffic accidents will account for 3.6% of the total deaths per year, more than the three major disasters that we have known as cancer, AIDS and war, and will become the fifth major death factors which threatening human health. This not only caused a lot of casualties, but also seriously affected the economic development and social stability, road traffic problems are always threatening the health and safety of society. And in many traffic accidents, that caused by drink driving had a large proportion. In china, every year tens of thousands traffic accidents due to drink driving, and more than 50% of fatal accidents were related to drink driving. Drink driving hazards shocking, has become the traffic accident's first "killer". According to China's traffic department, drink driving traffic accident rate was at least 5 to 6 times higher than that of general traffic accident (Wang, 1999).

In 2004, China's State Administration of Quality Supervision, Inspection and Quarantine issued a national standard "vehicle driver blood, breath alcohol threshold and test" (GB19522-2004). The standard stipulates that drink driving is the driving behavior that the alcohol content of the vehicle driver's blood greater than or equal to 20mg / 100ml and less than 80mg / 100ml, while drunk driving is the behavior that driver's blood alcohol content greater than or equal to 80mg / 100ml. The introduction of the standard for the issue of drink driving in China has a unified reference standard for the first time.

We all knew that there was a very close relationship between BAC and traffic accidents. A roadside survey showed for every 0.02(μg /ml) increase in BAC, fatal crash increased by nearly 2 times, and when BAC was 0.05(μg /ml) to 0.09(μg /ml), fatal collision accident risk at least 9 times the driver with BAC was 0(μg /ml)(Zhao,2007[a]). Different BAC effect on the driver's driving safety was different, especially the driver's psychological impact is unpredictable, so we need to further verify the reliability of the current drink driving and drunk driving standards.

Many researchers have begun to focus on the psychological effects of different BAC on the driver. Alcohol seriously affects the driver's dangerous perception. Danger perception is one of the important aspects of driving ability. It mainly refers to the subjective cognition and evaluation of the potential danger to the external environment, and the corresponding preparation behavior (Li,2001). Studies have shown that the level of risk perception was negatively correlated with the accident rate, and was related to the driver’s age and experience. Alcohol can reduce the risk perception, change the driver's attitude towards traffic safety, overestimate his own driving skill, thus speeding, dangerous overtaking, illegal, etc., which increased the accident rate(Li,2001). Furthermore, alcohol could decrease the response rate and

attention and showed a dose-effect relationship(Zhao,2007[a]).

In summary, to investigate the relationship between BAC and driver's psychological ability, this study focused on perceptual ability and attention concentration ability, tried to analysis the impact of BAC on these two capabilities, thereby revealed the impact of alcohol on traffic safety, and provide empirical evidence for traffic safety management.

2. Subjects and Methods

2.1 Subjects

We selected 34 male drivers randomly as the subjects, who hold the People's Republic of China motor vehicle driving C1 card, and had a certain driving experience. Among them, the effective driver were 26, the average age was 37.80 ± 4.96 years, the average weight was 75.32 ± 8.92 kg, the average driving range was 3.34 ± 2.75 million km. All the drivers were healthy, without mental or mental illness history, no alcohol allergy history and alcohol dependence (using the "Michigan Alcohol Dependency Questionnaire" screening).

2.2 Methods

2.2.1 Experimental design

The experiment was designed with single factor repeated measurement, independent variable was different BAC (20mg /100ml、50mg /100ml、80mg /100ml、100mg/100ml). Each subject completed the tests of perceptual ability (velocity estimation ability and depth-perception ability) and attention concentration ability.

2.2.2 Environmental requirements

Experimental area is divided into drinking area, test area and rest room. Temperature are controlled at 20-25℃, and light is moderate keep quiet, the entire test area is no noise and other interference.

2.2.3 Apparatus and methods

Velocity Estimation Tester: Test speed perception, which produced by Anhui Sanlian Technology Co., Ltd. (Model: LJ9101-B). The subject needs to observe a light-spot moving on constant speed for a period and then estimate the duration the spot needs to pass a blind zone. Measure the deviation of time (in s). Repeat 6 times and take the average.

Depth Perception Tester: Test the ability to estimate the distance, which produced by East China Normal University Science and Technology Instrument Factory (type: EP503A). The subject needs to use a remote controller to move the middle vertical bar to the same plane as the two standard side bars. Measure the deviation of distance (in centimeter). The subject was asked to test 8 times, then we recorded the error, and calculate the error average.

Attention Concentration Tester: Test the time to attention to stay on the selected object, which produced by East China Normal University Science and Technology Instrument Factory (type: EP701C). The subject needs to hold and move an L-shaped infrared bar to track a moving target in three graphic trajectories (round, hexagonal and triangle). Each trajectory lasts for 20 s. Measure the averaged on-target time (in s) and off-target frequency (in counts).

2.2.4 Experimental procedure

The drivers were requested not to drink within 48 hours, and had adequate sleep (sleep every night for more than 7 hours). The drivers had unified diet during the test. In addition, the drivers were asked to familiar with the all the testing tools to eliminate or reduce the practice and fatigue effects on the experimental results.

How to drink? According to Chinese people drinking habits, we chose 52% wine, and supplemented beef, peanuts and tea, etc. Then the drinking time was controlled in 8-10 minutes.

Alcohol concentration detection method: The drivers were weighed body weight, had a break of 15 minutes after breakfast, and then accepted the test with no drinking. We calculated how much wine to drink under four BAC (20mg /100ml、50mg /100ml、80mg /100ml、100mg/100ml) according to drivers' weight and alcohol clearance rate (0.1 mg / ml per hour, that is alcohol concentration drops 0.1mg per hour in 1ml alcohol). Next, we began to test 15 minutes later. Every 10 minutes, we detected 2times and took the higher value, and then converted into BAC. When the driver's BAC reached the preset concentration, the experimental indicator can be tested until the entire experiment is completed.

2.2.5 Data analysis

All data were coded and analyzed using SPSS16.0 for repeated measure ANOVA in this study. All effects were considered statistically significant based on the significance level of 0.05.

3. Results

3.1 The variation of participants' perceptual ability on condition of different BAC

Table 1 Describe statistics (Mean ± Std deviation) of perceptual ability on condition of different BAC.

Measurements	Values(Mean ± Std deviation) on different BAC（mg/100ml）				
	0	20	50	80	100
velocity estimation error（s）	0.46±0.28	0.43±0.43	0.42±0.36	0.47±0.42	0.47±0.41
depth-perception error（cm）	0.42±0.30	0.63±0.60	0.84±0.81	0.84±0.84	1.02±0.76

N=26

As shown in table 1, on the basis of descriptive statistics, repeated measure ANOVA was used to analyze the difference. Furthermore, the indicators which had significant differences were post-tested. The results were shown in the table below.

Table 2 The difference analysis of perceptual ability test under five BAC conditions

Measurements	df	MS	F	Post-test results

velocity estimation error（s）	4	0.009	0.192	
depth-perception error（cm）	4	0.581	2.654**	1<3*, 1<4*, 1<5**, 2<5**

* Significance level < 0.05, ** Significance level < 0.001, the numbers of BAC ranging from 1 to 5 represent 0 mg / 100ml, 20 mg / 100ml, 50 mg / 100ml, 80 mg / 100ml, 100 mg / 100ml or more, respectively.

No significant difference among the five sets of data was observed for drivers' velocity estimation ability. However, we found that there was a significant difference in depth perception, namely, depth perception was significantly influenced by alcohol, especially when the BAC reached 50mg / 100ml or more, the drivers' depth perception error value was significantly higher than that of low alcohol concentration.

3.2 The variation of participants' attention concentration ability on condition of different BAC

Table 3 Describe statistics (Mean ± Std deviation) of attention concentration ability on condition of different BAC.

Measurements	Values(Mean ± Std deviation) on different BAC（mg/100ml）				
	0	20	50	80	100
attention concentration time（s）	19.31±0.50	19.15±0.47	19.03±0.48	18.92±0.92	18.69±0.86

As shown in table 1, on the basis of descriptive statistics, repeated measure ANOVA was used to analyze the data. Furthermore, the indicators which had significant differences were post-tested. The results were shown in the table below.

Table 4 The difference analysis of attention concentration ability test under five BAC conditions

Measurements	df	MS	F	Post-test results
attention concentration time（s）	4	0.975	3.505**	1>3*, 1>4*, 1>5**, 2>3*, 2>4*, 2>5**, 3>4*, 3>5**, 4>5*

* Significance level < 0.05, ** Significance level < 0.001, the numbers of BAC ranging from 1 to 5 represent 0 mg / 100ml, 20 mg / 100ml, 50 mg / 100ml, 80 mg / 100ml, 100 mg / 100ml or more, respectively.

The impact of BAC to drivers' attention concentration ability was most prominent, that was to say, drivers' attention concentration time decreased

significantly as BAC increased. Specifically, when no drinking, the drivers could focus on the object very well, keeping the longest time. After drinking, they need to rely on determination to focus attention, at this point, the concentration time became shorter, when the BAC reached 50mg/100ml, the concentration time has changed significantly. Particularly, when BAC was 80mg/100ml or in the state of drunk driving， drivers' attention concentration ability decreased obviously.

4. Discussion

In this study, twenty-six drivers completed the experiment task after they drunk some wine when the BAC achieved predetermined value. The main findings suggest that the drivers' perception and behavior are differentially affected by alcohol.

Alcohol can affect safe driving behavior by influencing a variety of factors in driver's perceived athletic ability (Li,2001). Safe drivers were observed to be stronger at spatial perception(Depth perception), and motion perception (velocity estimation)was equally important to both safe drivers and accident drivers(Wang,2016). All these findings enhance the importance Of visual and spatial cognition in driving safety (Kotecha et al.2008; Kobayashi, 1967; West et al., 2003)

Perceptual ability is one of the important capabilities of the driver's driving process, and it is the overall grasp of the task. Velocity perception belongs to a kind of motion perception, which refers to the ability to estimate the speed of movement of the object, and has a certain relationship with the time perception, in addition, there is an important significance in human practice. Thus, we used velocity estimation to measure velocity perception, and the accuracy of that could be used as an indicator of velocity evaluation. After drinking, the driver's ability to judge will be affected, which reduced its ability to estimate the speed. The results showed that with the increase of BAC, the error of t velocity evaluation was not obvious. But when BAC is low, the velocity estimation error decreased gradually. This may be due to a small amount of alcohol, the drivers' excitement improved and the vigilance increased, then the speed of estimated ability rose correspondingly. When BAC reached 50mg / 100ml or more, The velocity estimation error was on the rise, that was to say, the higher BAC would affect the ability of the drivers to judge the speed.

Furthermore, depth perception refers to the ability of the human visual organs to determine the distance of the three-dimensional space of a object (Guo,1999). The driver's depth perception includes the distance between the object and himself and the distance between the different objects. According to the purpose of judgment, their own state of motion can be divided into static depth perception and dynamic depth perception, which is more important to the driver to hold overall traffic conditions. Previous studies have shown that, more than 70% of traffic accidents were caused by hypervelocity or wrong distance judgment(Deng,2004). This study examined the dynamic depth perception of drivers under different BAC. The results showed that with the BAC increased, the depth perception error of the drivers appeared a significant upward trend. That is, the drivers' depth perception ability was significantly reduced. When BAC reached 80mg / 100ml or more, the error values were significantly higher than that of no drinking. This indicated that drinking driving

or drunk driving caused insufficient accuracy in perceived object distance seriously.

From the perspective of attention, accident drivers were observed to lose their concentration more easily and to perform more weakly in expanding their attention range, which may increase distractions and failures to notice important information while driving (Klauer et al., 2006). Studies have shown that alcohol affected the drivers' attention, when the BAC reached 10-20mg / 100ml, there would be attention distraction (Zhao,2004[b]). It suggested that attention was an important factor to safe Driving. In this study, the drivers' attention concentration ability began to be affected when BAC was 20mg / 100ml, then with BAC further increased, the inhibitory effect of alcohol was enhanced, the time to focus attention gradually shortened, the ability declined, which indicated that the higher BAC the more poor capacity to concentrate attention, and the more narrow attention.

5. Conclusion

Driver is one of the main participants in road traffic, to prevent drink driving and drunk driving has become the focus of current road safety work. The study selected the drivers who had a certain driving experience as the research object, explored the variation of the drivers' perceptual ability and attention concentration ability on condition of different Blood Alcohol Concentration. Concluded as follows, BAC effected drivers' perceptual ability and attention concentration ability obviously. After drinking, drivers showed insufficient accuracy in perceiving object distance, worse capacity to concentrate attention, narrow attention span, and poor ability to estimate danger.

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