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# Study on the Influence of Driver Anxiety on Driving Behavior During Car-Following

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## ABSTRACT

Traffic includes people, cars and the environment, and people are subjective and changeable. When the driver's psychology or behavior changes, the possibility of accident will increase. Emotion is a major factor affecting the psychological and physiological changes of drivers. Anxiety is generally considered to be one of the emotions that are easy to cause traffic accidents. For this, this paper collects and counts the driving data through the design of simulation driving experiment. At the same time, an emotion induced experiment was designed to simulate the changes of driving behavior caused by anxiety during car-following, and the process was recorded. The average analysis method is used to summarize and analyze the driving behavior under anxiety and calm mood in car-following driving, which also provides important theoretical support for the future research on traffic safety.

***Keywords:*** driving behavior; driving mood; dar-following; simulated driving

## INTRODUCTION

Nowadays, with the rapid development of transportation, the number of private cars has greatly increased in recent years, and traffic accidents have also increased, with the number of casualties in traffic accidents on the rise. According to official data, traffic accidents caused directly or indirectly by factors considered account for more than 90% of the total traffic accidents, of which 70% are caused by vehicle drivers.

Advanced driver assistance system (ADAS), advanced vehicle control and safety system (AVCSS), advanced traveler information system (ATIS), advanced traffic management system (ATM) and many other its subsystems are directly related to human and vehicle units, and take the traffic flow formed by vehicle operation as the main research object. Among all the elements of the transportation system, the driver with subjective initiative is the direct participant and decision-maker of the operation of the transportation system. The rationality of decision-making and the correctness of behavior are the key to the safe and effective operation of transportation system. However, due to the limitations of people's working ability and cognitive level in physical and brain work, the psychological state of car drivers is not always able to maintain the best working state, nor can it ensure that every behavior is the best decision.

In order to establish a perfect active and safe driving warning system, two key problems need to be solved. First, accurately perceive the vehicle operating environment and reasonably assess the risk. The second is to accurately judge the driving intention. The final behavior of drivers depends on the interaction of emotion, cognition and consciousness. Exploring the coupling mechanism between drivers' micro psychological characteristics is the key to improve the core algorithm of active safe driving warning system. Therefore, it is necessary to study the relationship between drivers' psychological state and behavior, so as to further promote the development of intelligent transportation system.

## EXPERIMENTAL METHOD

### (1) Experimental materials and equipment

The experimental equipment used in this experiment mainly includes driving simulator. The simulated driving device is a simulation experimental platform for the integrated road system of human and vehicle environment and the multi person and multi machine interactive environment, which is constructed by using the road builder and UC win / road software, according to the road attributes, traffic volume and other parameters of the on-site driving test. Using real driving experiments to collect data is time-consuming and expensive, and it is difficult to ensure the safety of driving behavior under emotional stimulation. Simulation driving has the advantages of safety, low cost and easy control.

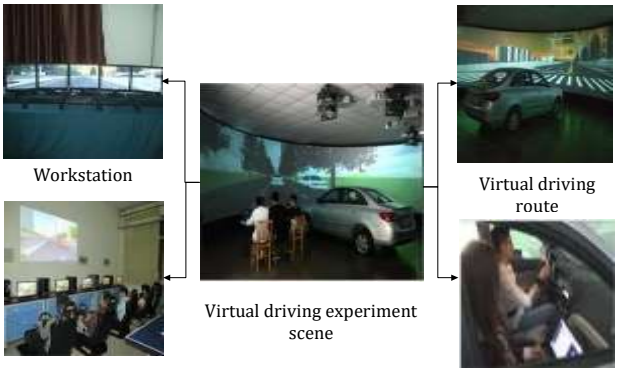


**FIGURE 1:** simulated driving equipment

**(2) Experimental subject**

Consider the impact of various factors on driving behavior, including age, gender, health level, etc. A total of 100 men and 100 women were selected as the final experimental drivers, which met the above conditions.

**(3) Experimental design of inducing emotion**

This study uses multi person driving simulation to simulate driver driving experiments, and takes pictures, videos, etc. as emotional guidance materials to achieve emotional guidance for drivers. The subjects were required to adjust their emotions before the experiment to ensure that they were calm at the beginning of the experiment.

The emotional induction steps and some induction materials are shown in the following figure:

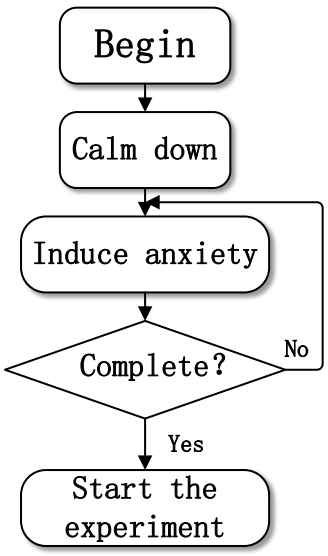


**FIGURE 2:** flow chart of emotion induction

**FIGURE 3:** Some driving emotional visual stimulation materials

**(4) Operation of driving simulation experiment**

- Use the simulation software to create the scene that needs to simulate driving, establish a folder to store the exported data in advance, and check the vehicle parameters that need to be collected for statistics.
- Our laboratory staff will elaborate in detail the matters needing attention in the experiment, the details of operation in the process and the importance of psychological and emotional construction, so that the laboratory staff can maintain a reassuring mood and rigorous experimental attitude.
- After the driver has made clear the content of the experiment, the scene debugging of simulated driving is carried out. A group of four people, two people do car following activities, and two people do the driving assistance interference required for the experiment in the side lane. During car following, the front car is the main engine, and the rear car is the auxiliary machine free cluster.
- Collect calm driving data as the control group.
- The experiment personnel were stimulated with anxiety, and the emotion induction experiment process as described above was carried out. After the induction, it is necessary to judge whether it conforms to the selected emotion in combination with subjective factors such as facial expression, expression and the feelings of the experimenter. After that, it is necessary to conduct the simulated driving experiment again and record the data to complete the collection of vehicle parameters

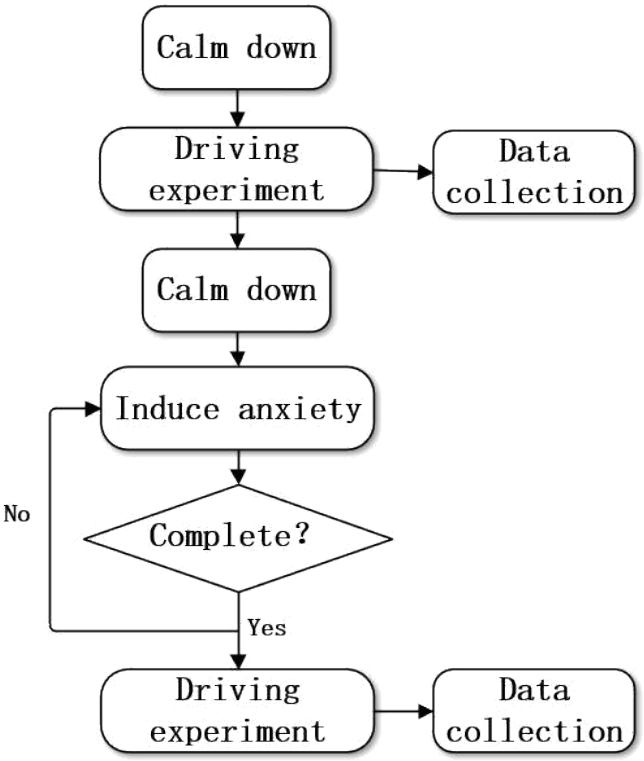


**FIGURE 4:** Flow chart of emotion inducing experiment

**(2) Analysis of Experimental Data**

Combined with previous research and driving practice, this paper adopts the test design of the previous chapter to analyze various test parameters of the vehicle, and selects typical vehicle operating parameters, acceleration, steering wheel angle, engine speed, accelerator pedal force, steering speed, vehicle yaw angle and other parameters from the test results, and carries out average, standard deviation, maximum and minimum. The parameter name, unit and other information are displayed in the table. By using 20 indicators, including the mean value, standard deviation, maximum and minimum of vehicle condition parameters, data analysis is carried out. Due to the differences in driving behavior indicators of drivers under different driving emotions, it is required to compare normal emotions with other typical driving emotions. Through the t-test of samples, the significance of the impact of different emotional indexes on driving emotional states can be obtained, the parameters with significant influence are selected and analyzed.

**TABLE 1**: Characteristic parameter

| Parameter name | Symbolic representation | unit |
|---|---|---|
| engine speed | RPM | r/min |
| Vehicle speed | v | Km/h |
| Vehicle acceleration | a | $m/s^2$ |
| Steering wheel input value | St | r |
| Accelerator pedal input value | T | r |
| Lane centerline distance | S | m |

In the t-test data, only when the sig value is less than 0.05, the corresponding parameter indicates that the general situation of this index data has obvious differences between various types of situations. From the experimental data, it can be seen that the average speed, acceleration, accelerator pedal force, yaw angle standard deviation of the vehicle under anxiety are significantly different from those under calm mood, which is manifested in the reduction of speed, acceleration the yaw angle of the vehicle increases.

**TABLE 2:** T-Test and analysis of driving behavior under anxiety (compared with calm mood)

| | Mean | SD | SEM | Min | Max | t | Sig. |
|---|---|---|---|---|---|---|---|
| RPM | -31.6823 | 331.82726 | 36.64419 | -104.537 | 41.22752 | -0.865 | 0.39 |
| v | -1.30732 | 3.01728 | 0.3332 | -1.97029 | -0.64435 | -3.923 | 0 |
| a | -10.9348 | 4.2333 | 0.46749 | -11.8604 | -10.0072 | -23.391 | 0 |
| St | -0.00021 | 0.00852 | 0.00094 | -0.00208 | 0.00166 | -0.222 | 0.825 |
| T | -0.10378 | 0.20464 | 0.0226 | -0.14875 | -0.05882 | -4.592 | 0 |
| S | 0.01146 | 0.77518 | 0.0856 | -0.15886 | 0.18179 | 0.134 | 0.894 |

## CONCLUSIONS

This study aims to analyze the changes of drivers' driving behavior under anxiety during car following. In the research, we designed and carried out experimental processes such as emotional induction and simulated driving, and completed the comparative analysis of driving behavior under anxiety and calm mood in car following driving through data statistical analysis, analysis method of comparing average value and other relevant methods. In the analysis, we believe that the main danger of driving under anxiety comes from vehicle yaw, this problem will cause the driver to interfere with adjacent vehicles or even crash.

In the subsequent research, the driving emotion of drivers can be identified through the driving data obtained in this study, so as to seek the further development of driving assistance technology and improve the safety of traffic operation.

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