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## Study on the Eye Movement Characteristics of Fire Hazard Identification in University Laboratories

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### Abstract

To explore different operators' eye movement indexes which can reflect the degree of fire hazard identification in university laboratories, the experiments were carried out in 60 undergraduate students, and these students were divided into 4 groups based on their gender and experimental experience. Taking the panorama of laboratories as stimulus materials, the Tobii X2 -30 eye tracker was used to carry out eye movement measurements, and the data of eye movement were analyzed by using the single-factor multivariate variance analysis and multiple comparison method. The results show that different gender has little influence on fire hazard identification in laboratories; the attention rate and sensitivity of fire hazard in experienced operators are 21.62% higher than that in inexperienced operators; in the five types of fire hazards, the subjects spent more time in aging circuit, which reached 22.13%. And the time spent in combustibles piled up randomly has the lowest percentage, only 17.90%. The data of fixation point count, blink count, average blink time and average pupil diameter has no significant difference. The different experimental experience levels of the subjects have significant influence on the eye movement results. The gaze trajectory of experienced subjects is hierarchical and logical. For inexperienced subjects, the trajectory is on the same horizontal line; what's more, both the back view and the saccade are multiple. Therefore, according to operator's professional experience level, the countermeasures for fire safety education and management in laboratory are put forward. These results can guide the fire safety management effectively in university laboratories.

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*Keywords:* university laboratories, fire hazard, eye movement characteristics, safety management

### 1. Introduction

Laboratory or practical work is considered a crucial component for students in science learning and fire is one of the most important crises in educational laboratory experiments. Improper operation and storage management of flammable and explosive hazardous chemicals, aging circuit, combustibles piled up randomly, overload operation of large equipment, non-compliant fire-fighting equipment and the blocked fire exit, are the potential fire hazards, which often unnecessarily, cause a large number of casualties, serious environmental damage and enormous material losses [1]. Thus, it is instructive to study the psychological indexes of different types laboratory operators on fire hazard for fire safety in university laboratories.

Eye tracker is a complex and precision psychological instrument. It can measure individual eye movement characteristics, and evaluate the validity of effective interface by visual cognitive physiological evaluation. Thus, the subjective influence of users can be effectively eliminated. Its essence is the allocation of human attention resources and the selection of more useful and attractive information. When the user reads texts or images, eye tracker records the gaze and saccade process, and determines the location of the eye's browsing, stay, and the watching time completely.

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The expert-novice paradigm is emerged in recent years. In this paradigm, the subject is divided into expert group and novice group, and their eye movement data were gathered [2]. The differences of fixation time, fixation points amount and saccade trajectory were compared and analyzed to obtain the information selection patterns for operator visual processing. And the attention allocation, workload status and other information were also grasped in the process of equipment operation [3].

At present, eye movement characteristics are widely used in various fields. Yang et al [4] studied the influence of confined space on the operators in normal environment and deep well with high temperature environment by comparing the eye movements of 20 close members. Zhang et al [5] described the research status and application prospect of eye tracking technology in the field of civil aviation flight from the cockpit man-machine interface design, the airport road environment construction, pilot training and aircraft safety driving. Lenskiy et al [6] achieved accurate positioning and segmentation of driver's eye based on colour and texture, and extracted the blink frequency and eye closing time for fatigue detection.

In general, rare eye movement research is carried out in the field of safety science and engineering, especially in laboratory fire hazard identification research. Therefore, this research studied the recognition degree of fire hazard in laboratory from different undergraduate operators, and measured their eye movement indexes when they were viewing the laboratory panorama. Then, these different data are used to reflect the difference of fire consciousness among each operator. At last, fire safety management basis is provided for strengthening university laboratory management.

## 2. Experiment

### 2.1. Method

30 experimental experienced junior students (including 15 male and 15 female) were selected, and their average age is 21. They have had a lot of laboratory courses. 30 non-experimental experienced freshmen (including 15 male and 15 female) were selected, and their average age is 19. The school has not offered laboratory course for them yet and they had no experiment experience before.

All of these subjects are from the same university in Changsha, China. They have healthy eyes (visual acuity level  $\geq 5.0$ [7], no color vision problem), and have no previous mental or neurological problems.

Some panoramic view of university laboratories were taken by using high pixel camera. After proper tailoring, montaging and typesetting, these pictures were added into A and B groups, and then they were shown manually by PowerPoint interface.

The pictures in group A are the complete panoramas. Subjects were asked to browse and find fire hazards in each chart, and the eye movements of each subject were recorded.

The slides in group B are five types fire hazards which were tailored in the panorama.

### 2.2. Instruments

Liquid crystal display, 1440×900, Lenovo L197WF, China; Eye tracker, Tobii X2-30, Sweden.

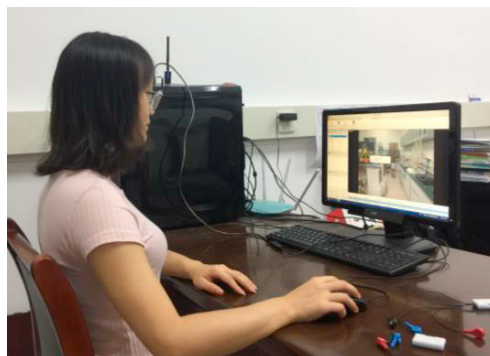


Fig. 1. The test process of eye tracker.

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