Using Eye Tracking Technology to Evaluate New Chinese Furniture Material Design

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Abstract. With the rapid economic growth in China, Chinese style furniture has revived quietly and "new Chinese furniture" that accords with the demand of the time has also been generated. Not only it is an inheritance of Chinese long-standing history and culture, but also it complies with the international trend. Material is an important design element in new Chinese furniture. With our scientific and technological progress, the methods and means of design have been continuously improving and updating, and the modes of design appraisal have been emerging endlessly. However, few research is on the design appraisal of materials used in new Chinese furniture. Eye-tracking technology takes users' eye movement as the basis of measurement and appraisal, which is relatively more suitable for the inspection of the visibility, characteristic meaning and interface layout of exterior elements. Thus, it can provide product development with objective, comparable and quantitative standards of measurement.

In this research, eye-tracking technology and the method of subjective assessment are combined and desktops in new Chinese furniture are taken as an example. The eye movement features and subjective assessment results in undergraduate respondents' preference assessment of four commonly used materials for desktops (bamboo, wood, glass and metal) are recorded. It is found out through analysis and comparison that there are significance differences between professional and non-professional respondents' assessment of the materials. In the assessment of materials, as the level of subjective assessment rises, the respondents clap their eyes on the materials at a longer time more frequently, and their pupil diameter becomes larger. However, it has nothing to do with the duration of continued watching. Therefore, the time and duration of watching, and pupil diameter can be taken as effective indexes in eye movement assessment of materials of new Chinese furniture.

Keywords: Eye tracking · New Chinese Furniture · Material design · Design appraisal

1 Introduction

With the rapid development of Chinese economy, Chinese furniture is also reviving quietly and "New Chinese Furniture" which meets the requirements of the age is generated. It is the inheritance of long-standing Chinese history and culture, complying

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with the international trend. New Chinese Furniture refers to furniture applying modern technology, equipment, materials and technique, meeting standardized and unitized requirements of modern furniture, reflecting characteristics of this age and adapting industrialized volume production with strong Chinese traditional cultural connotation and national features [1]. We can find that New Chinese Furniture design shall not only reflect new technology, new materials, new technique, new environment, new requirements and other features of the age but also pay attention to the research of Chinese culture, appreciation of the beauty, philosophy, style, temperament and other national features.

Material is an important design element of New Chinese Furniture. With scientific and technological progress, the design ways and means are improving and updating continuously and the ways of design evaluation is also emerging in endlessly. However, few people are researching the material design evaluation of New Chinese Furniture.

2 Eye Tracking Technology

Eye tracking technology uses sight movement of user as the measurement and evaluation basis, compares the visibility, representation implication and interface layout which are suitable for investigating the product appearance elements, which is able to provide objective, comparable and quantized measurement standard of product development.

Current eye trackers mostly applies infrared ray to catch cornea and the reflection principle of retina to record the user's eye movement track, fixation times, fixation period and other data [4]. According to research reports and materials published in recent years [5] show that eye tracker test parameters mainly include:

Eye movement frequency, Pupil size change, Average fixation standing time, Fixation point sequence, The first time to reach target interested area.

3 Experimental Method

3.1 Experimental Subject

There are 24 subjects in this experiment. All of them are graduate students, which mean they are all in marriageable age. There are 12 students of artistic design major including 6 males and 6 females; there are 12 students of non-design-related majors including 6 males and 6 females. All the subjects have normal naked eye vision or corrected visual acuity. The average age of them is 23.8 years old.

3.2 Experimental Apparatus

Experimental device is one iView X HED head-wearing eye tracker and one iMac computer with the resolution ratio of 1680*1050. Sampling frequency of eye tracker is 200 Hz. Presentation of experimental materials and data record and interpretation use

HED dedicated video analysis software BeGaze Mobile Video Analysis Software to complete. Experimental Materials

23 design works themed on New Chinese Furniture are chosen from furniture design course of senior students. After discussion and evaluation, works which are most representative for New Chinese Furniture material design are chosen. Keyshot 4.0 software is applied to render the design works. Glass, bamboo, wood and metal are endowed to the tea table in the same visual angle and four rendering effect sketches are obtained. See Fig. 1.

3.3 Experimental Procedures

The experiment is divided into two stages – eye movement experiment and evaluation experiment. The subjects do eye movement experiment and then evaluation experiment. Experiments are done separately to guarantee good sound insulation effect and uniform light condition in experimental environment.

Experimental procedures of eye movement experiment: (1) Guide the subject to sit in front of the designated table. Put on head-wearing eye tracker and make it able to catch eye data of the subject; (2) Guide the subject to stare at the smooth calibration plane of 5 independent calibration target points right ahead to complete eye calibration; (3) The experimenter explains the experimental instruction to the subject. The exercise experiment will start after the subject has grasped the experimental instruction correctly; iMac screen will display fixation point position figure with white ground. There is a black solid circle with the diameter of 20 mm in the center. The subject is asked to stare at this circle. After 5 s the formal experiment material will be presented; (5) When experimental material presents, eye tracker will record the fixation process of the subject and it will stop recording when the subject works out preferential judgment. (6) Exercise experiment is the same as the formal experimental procedures.

Procedures of subjective evaluation experiment are: (1) The experimenter explains the experimental instruction to the subject; (2) Experimental materials which are the same with eye movement experiment are presented. The subject will be given tea table evaluation form of different materials to do subjective evaluation records.

Fig. 1. Tea table top (glass, bamboo, wood, metal) effect sketch

4 Experimental Result

Look for the relationship between eye movement data and evaluation grade by analyzing the relationship between eye movement data and evaluation grade with the influence of tea tables of different top materials. Select eye movement indicators which are effective during the evaluation of eye movement analysis on New Chinese Furniture material design (Fig. 2).

We can find in this figure that subjects will have more fixation times when they have higher evaluation grade in the subjective evaluation on different table top materials. They will have less fixation times when they have lower evaluation grade. Subjective evaluation grade has the same changing principle with fixation times of subjects (Fig. 3).

We can find in this figure that subjects will have longer fixation period when they have higher evaluation grade in the subjective evaluation of different table top materials. They will have shorter fixation period when they have lower evaluation grade. Subjective evaluation grade has the same changing principle with fixation period of subjects (Fig. 4).

We can find in this figure that subjects will have shorter fixation point duration when they have higher evaluation grade in the subjective evaluation of different table top materials. They will have longer fixation point duration when they have lower evaluation grade. By analyzing fixation point distribution, we can find that fixation points of subjects will move between two tea tables of different materials when they are

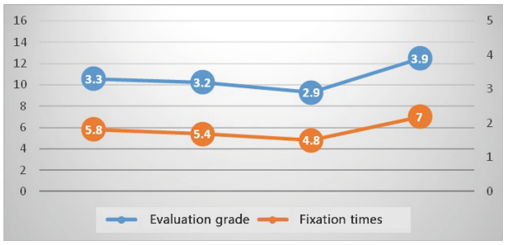

Fig. 2. Broken line chart of evaluation grade and fixation times of subjects with the influence of different materials.

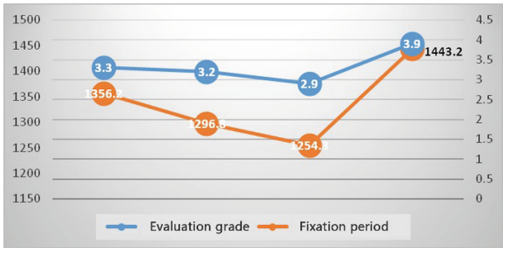

Fig. 3. Broken line chart of evaluation grade and fixation period of subjects with the influence of different materials.

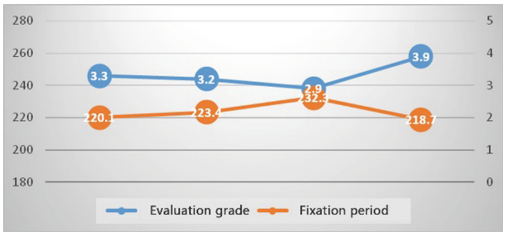

Fig. 4. Broken line chart of evaluation grade and fixation point duration of subjects with the influence of different materials.

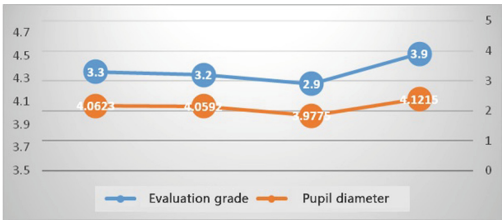

Fig. 5. Broken line chart of evaluation grade and pupil diameter of subjects with the influence of different materials.

judging their preference. At this moment subjects are comparing and making judgment. They will be more familiar with those with more fixation times and the fixation point duration will reduce when they fix on it again. Similarly, degree of familiarity of experimental material is also a factor to influence the fixation point duration of subjects. For strange observation object, subjects will stay longer at certain fixation point to observe such material. Therefore, change trend of fixation point duration is contrary to change trend of subjective evaluation grade (Fig. 5).

We can find in this figure that subjects will have larger pupil diameter when they have higher evaluation grade in the subjective evaluation of different tea table top materials. They will have smaller pupil diameter when they have lower evaluation grade. Subjective evaluation grade has the same changing principle with pupil diameter of subjects.

5 Conclusion

This article tries to design the surface material design research of New Chinese Furniture by eye movement tracking technology. The research finds out that the more fixation times subjects pay on table material with the improvement of subjective evaluation level during the evaluation of subjects on take material, the longer fixation period will be and the larger pupil diameter will be. However, fixation point duration is on the contrary. Therefore, fixation times, fixation period, fixation point duration and

pupil diameter can be used as effective indicators of eye movement evaluation of New Chinese Furniture.

Certainly this article has its limitation to some extent since it only uses tea table top material design with new Chinese style as the example to research the relationship among fixation times, fixation period, fixation point duration, pupil diameter and material evaluation grade in eye movement tracking technology indicators without considering the influence of color, structure, environment, texture and other factors on eye movement indicators. Therefore, it can be further expanded in future research process.

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