

# A Study of Cognitive Behavior in Relation to the Elderly Visual Experiences

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**Abstract.** Makepeace in his 1998 article describes how enjoyment and pleasure also factor into the function of an object [1]. Since visual impression is the first occurrence of visual perception, and all human visual experiences are determined by design, the quality of product design is closely associated with the effect an object has on a viewer and may determine their understanding and experience of it. Since China will have the most aged population in the world by 2050, this study takes into consideration the rapidly growing elderly population globally and how currently design practice ignores the changing perceptual habits caused by physical aging. It explores the necessity of evaluating these changes, and the relationship between the visual experience and emotional reflection. A data collection methodology, comprised of two analytical assessment tools, was utilized to determine results. The first approach, Tasting Board System (TBS), was created by the author to gauge subjective preferences. The second, Eye Tracking (ET) Device, evaluates objective reflection. The results of the study identify the common cognitive features of the elderly so that it may positively affect design practice and enhance pleasurable visual experience.

**Keywords:** The elderly, cognitive features, visual experience.

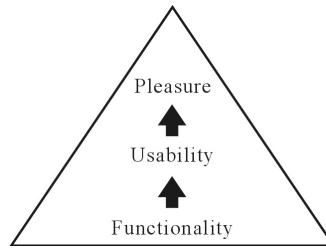
## 1 Introduction

Design considerations for human factors have acquired a new meaning in the 21st century. Around the new direction of design development and the new issues, the design philosophy of User Centered Design (UCD) has been proposed and developing nearly three decades of time, from Usability to User Experience (UE). However, in recent years, new trends have been emerging. In 2007, Norman issued a theoretical funder of UCD and introduced new opinion of emotional design [2]. Earlier year of 2002, Jordan proposed a new design philosophy, beyond usability and designing pleasurable product, they both focused on the procedure of designing products could bring in the feelings of pleasure and happiness to humans.

Jordan also indicated that his hierarchy of consumer needs as showed in figure 1, the trends explained that a product design should not only make usability to create

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**Fig. 1.** Jordan's hierarchy of consumer needs (Jordan, 2000)

pleasurable moods but also employ an active role that makes the user enjoy using the appliance with ease [3]. Besides, many scholars have different views on the functional definition, such as Makepeace (1998) has indicated that the function has been too narrowly defined, it means more than just use, Enjoyment and pleasure are part of the function of an object as well [1].

The visual impression is the first occurrence to human perception for receiving the external information, and all designs are associated with the human visual experience (VE). Product information is received through the eyes, and then assessed. Therefore, product design quality is closely related to its visual presented and whether it can bring a good mood to users for their cognitive experiences. According to the statistics of questionnaire on the survey, 100 percent of participants confirmed that pleasurable emotion is benefit to people health, and a good product should to make the pleasurable emotion to user.

Vision is the most important sensation of human with 83 percent in total of human sensory organs, as well as the types of different cognition between male and female in form and color. In 2006, Mather pointed out that vision is usually the first sense that engages when we experience a product and it can be processing visual stimuli alone consumes over half of the neurons in the brain's cerebral cortex [4]. Moreover, Adank and Warell also indicated that vision both communicates the descriptive characteristic of a product and also allows us to assess the aesthetic qualities of what we see in 2009 [5]. Obviously, pleasurable design moves to emotional experience level beyond 'usability', will embody the design in the 21st century, and also demonstrate the trend of integration both in functional and emotional.

VE is related to the communication relationship between vision and product. The satisfied relationship between them will benefit to user pleasant mood either their see or use of any product. Therefore, VE will involved in two aspects what user subjective preferences and stimulus objective presentation. Based on the data of the survey, participants with 96 percent confirmed positively that it can bring them pleasurable mood when visual representation of products is coincides with the personal cognitive preference. Obviously, the positive or negative user experience on VE assessment depends on the consistency of user subjective desired and objective reflection. In fact, many designers are unconsciously to ignore the user's VE feelings with individual subjective understanding, and easily make the designing results with adverse effects. Hence, it will be necessary that to clarify the factors of effecting user's pleasurable mood for considering and avoiding the occurrence of poor VE.

Because of cognitive feature is different in deferent age phase. Thus, their cognitive feature needs to be segmented to clarify the different age group. The Chinese

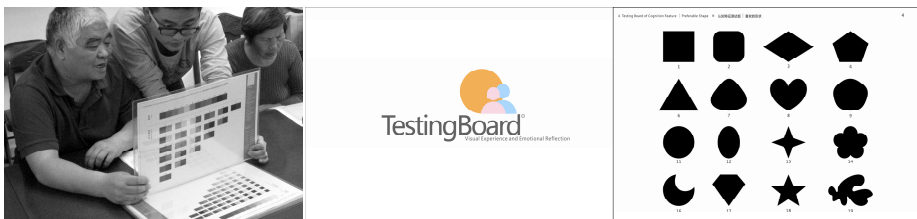
elderly are locked as the study target due to the aging society worldwide rapid accelerating, and its typical significance is that China will be the largest aged society with one fifth percent of the elderly population in the world in 2050 [6]. Furthermore, human physiologic changes with age are very obvious especially in the elderly. Their ability both in cognition and action begin gradually decline in vision, hearing, touching, smelling and tasting, which lead their difficulties in perception, experience and external stimulus, thus, consideration their physiological variation, from perception perspective to clarify their VE features in order to improve the elderly satisfaction with pleasant emotion.

The study therefore aims at the survey of the elderly VE common cognitive features caused by physical changing with the following three objectives: i.e. 1) to clarify the elderly subjective preference factors in VE; 2) to define the elderly objective attention factors in VE; and 3) to propose the elderly the pleasant factors in VE.

## 2 Methods

The study conducted on the basis of series of data collection and analyses from 24 participants invited in two approaches, which are subjective preference and objective reflection tests, i.e. both test board and eye tracking devices. The VE assessment was special designed for the elderly with focuses on four test categories selected from TBS including in color, shape, pattern and material/texture. Especially the color category, it was separated into three themes i.e. color/hue, color/purity, color/brightness. Through the data collection, processing, analysis, statistic, to extracted two sets of valid data visualized for comparison their distinction and similarity, and then to refer the comparison of the data visualized in subjective preference and objective reflection to discuss and clarify the results of the elderly pleasant factors in VE. The conclusion will be a reference to the elderly products design and its research.

**TBS.** A special VE test tool for the elderly created by author. It was composed by a series various contents in many aspects for VE test as showed in figure 2. Considering the factors of the elderly adaptability with physiological function decline e.g. visual difficulty, slow response, inattention, confusing, forgetful and easy tired circumstance etc. therefore, it was reduced the number of test stimulus as far as possible so that to maximize the test stimulus effect and to make the participants can easy to recognize, understand and select within one hour. In the study, four categories were selected and used for collect the elderly subjective preference data.



**Fig. 2.** Partial example of TBS assessment

**ET.** An eye tracker study device. In the study, Tobii X60, a brand and model, stand-alone eye tracking units was adopted for data collecting in evaluating the elderly objective reflection as showed in figure 3. The stimuli setup in ET was consistent with TBS, but just show the stimulus images only. Each test categories was displayed 5 seconds on screen for collecting the data of eye tracking metrics and calculated the raw gaze data that indicated regions of interest with a high fixation density.



**Fig. 3.** Objective reflection test (provided by Tobii X60)

### 3 Primary Studies

Twenty four participants are invited randomly by phone from a name list with 240 senior citizens provided by assist institutions (Elderly Activity Center, Guangzhou, China), ages ranged from 60 to 80 years old. All participants are completely voluntary with consent signed for joining the surveys of TBS and ET tests.

The demography shows the composition of the participations that all participants are chinese, 13 of them are female (54%), and 11 of them are male (46%). 25 percent of them are from east of China, 54 percent are from south, 13 percent are from central with 8 percent are no answer. From point of view of education level, of 4 percent are middle school level, 8 percent are high school level, 8 percent are vocational high schools level, 13 percent are polytechnic school level, 4 percent are senior college level, 58 percent are BA/BS level and 4 percent are MA and above levels.

There are 75 percent of them with visual impairment, 21 percent of them are normal and 4 percent of participants without answer. The visual impairment are mainly disorders in presbyopia, cataract, myopia, maculopathy, lack of aqueous humor, in partially or in entirely or mixed. Indeed, there are significant difficulties and challenges in the elderly study, because of most of them refused invitation to participate the survey e.g. they doubt that the data collected from them maybe used in commercial purpose, worry about trouble and being deceived, no time available, uninterested etc. besides, their state of health may is the mainly reasons. Furthermore, decline of physical and cognitive difficulty easy to make them fidget, lack of patience.

Considering the elderly special difficulties and disorders, such as dysphoria, distraction and easily fatigue, the whole test time controlled and completed within one hour in order to ensure the best effect of data collection and avoiding the occurrence of error data collection.

Purpose for the objectivity of data collection, individual uncertain information also need to be corrected, such as some single options of data collection, few participants selected more or none under the limited options of test required, in this case, the first

selection is considered valid. Any irrelevant, unfinished, unconfirmed and wrong answer is as invalid data to be eliminated. All participants are accepted the TBS test and ET test. The valid data of ET test adopted based on the participants' fixation. Because of the elderly visual difficulties/impairment reasons, 75% of participants have different levels and types of vision problems. Through the data analysis of ET test recorded, 11 participants' data shown that their eyes have difficulties to focus on right fixation accurately on stimulus and mainly free to watch outside of the stimulus. Therefore, the valid data used is 13 participants' data record including 9 of them with exact fixations and 4 of them have better fixations. The table 1 shows that all female participants are better than male in exact fixations but lower than male in total valid data.

Besides, each test stimulus in ET test was displayed on the screen for 5 seconds, and the data capture adopted start from 2 seconds for calculating so as to avoid visual inadaptation to participants in the first seconds. The other 11 participant's data of ET test are as invalid data are eliminated in this study.

**Table 1.** The result of participants tested (n=24)

Note: Y=Yes, N=No, NA= No Answer, E=Exact, B= Better, ME=Maximum Error, NE=No Effect, V= Valid, I=Invalid

Gender	Participant	Visual Difficulty			TB Test	Eye Tracking Testing				Valid	
Kind of Result		Y	No	NA		E	B	ME	NE	V	I
Male (%)	54	33	13	0	54	17	17	8	4	34	12
Female (%)	46	42	8	4	46	21	0	33	0	21	33
Total (%)	100	100			100	100				100	

The following data presented a visually display in two modes: i.e. 1) the elderly subjective preferences data in bar chart from TBS; and 2) the elderly objective reflection generated from ET test in cluster visual graphic. The cluster visualization is an area of graphic representation, which collects those gaze data points (clusters) from ET device with highly concentrations/accumulation of gaze data points superimposed on objects. This type of visualization can be used to calculate clusters of raw gaze data that indicate regions of interest, or similarly to count, heat maps display the areas with a high fixation density [7]. There are four categories of test selected with six themes in relation to the main aspects of VE in color/hue, color/purity, color/brightness, sharp, material/texture, and pattern. Each of the categories and themes of data is conducted by visualization in order to easy to contrast those two sets of data and extract the valuable information from consistent and inconsistent.

### Figure Description

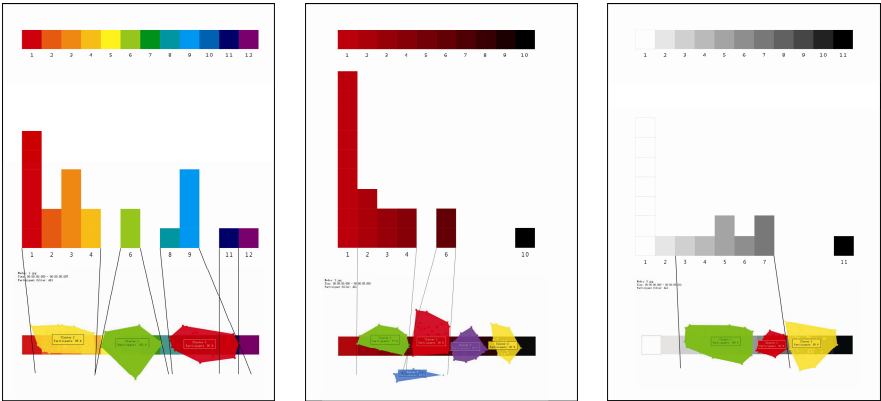
*Line:* Indication of corresponding range or similarity what relation between the personal preference and objective attraction.

*Bar Chart:* Indication of options degree of participants selected. The bar with color is show that the personal preference selected is correspond with objective attraction, on the contrary is inconformity with the gray color.

*Position of Graphic on the Figure:* In the Figure 4, on the top of the figure is the TBS test contents. On the middle of the figure are the personal preference selected by participants. On the bottom of the figure are general calculating data of ET tests what cluster of participants' raw gaze. In the Figure 6, 8 and 10, on the left of the figure are general calculating data of ET tests what cluster of participants' raw gaze. On the right of the figure are the personal preference selected by participants. In the Figure 7, 9 and 11 the figure description as following:  
*Cluster:* Indicated regions of interest.  
*Participants:* The percentage of participants is attracted by objective attraction.  
*Consistency with Personal Preference:* Indication of personal preference in line with the objective attraction. The effective data adopted is selected under the consistency principles with at least more than half of the stimulus covered by personal preference.

4 Results and Discussions

**Color.** On the tests of color categories, 3 themes (i.e. color/hue, color/purity, col- or/brightness) were selected from TBS. Figure 4 and 5 illustrated the statistical results of color/hue No. 2, 3, 4, 6, 8, 9, 11, color/purity No. 2, 3, 4, 6, and color/brightness No. 3, 4, 5, 6, 7, which participants preferred.



**Fig. 4.** Consistency between personal preference and objective attraction in color/hue, col- or/purity and color/brightness

Cluster	Hue			Purity		Brightness	
Participants (%)	100%	85%	85%	77%	92%	100%	92%
Consistency with Personal Preference							

**Fig. 5.** Consistency of color between personal preference and objective attraction

These participants preferred color are also consistency with objective attraction closely as well. These consistencies of colors obviously show the distinguished feature i.e. wide range of color/hue covered from No. 1 to 11, higher color/purity area of coverage from No. 2 to 6, and brighter brightness area of coverage from No. 3 to 7. The data reveal the information that most of the color/hue can bring the elderly pleasant, especially in red color, orange color and blue color, and the higher purity and medium-higher brightness color are even better to the elderly VE.

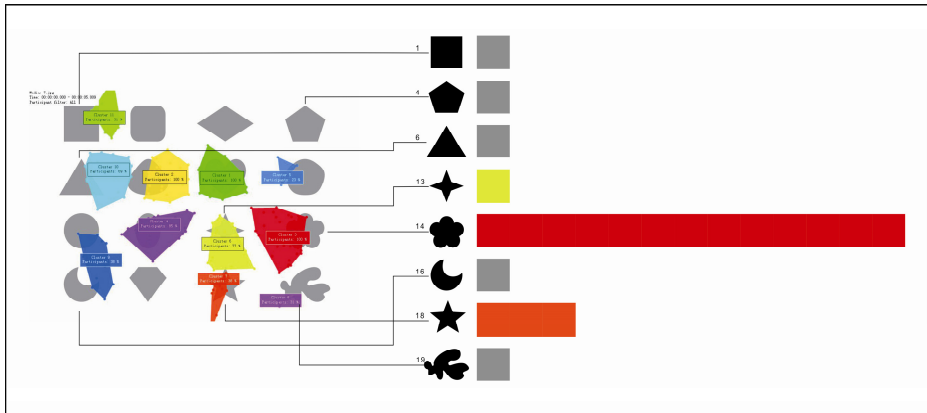


Fig. 6. Consistency between personal preference and objective attraction in shape




Cluster	14	13	18
Participants (%)	100%	77%	38%
Consistency with Personal Preference			

Fig. 7. Consistency of shape between personal preference and objective attraction

**Shape.** On the test of sharp category, the statistical results in figure 6 and 7 show that the participants preferred sharp are five-petal flowers, cross star and five-pointed star. These shapes are consistency with objective attraction closely, especially all participants paid close attention to the flower sharp and it is also the best preferred sharp with high degree of selected. Between the cross star sharp and five-pointed star, the simple sharp are more easy to attract the elderly vision than complicated shape even though favorite degree of five-pointed star is higher than cross star sharp. An interesting phenomenon needs to be notice that the three shapes have similar characteristics. Perhaps it shows that the sharp angle of star has the distinct stimulating effect to the elderly vision. Moreover, the five-pointed star is one of symbol in China, so it also naturally links the Chinese elderly emotion and their memory. Flower is the shape of five-pointed star variants, but it seems more natural, full and mature than shape of star.

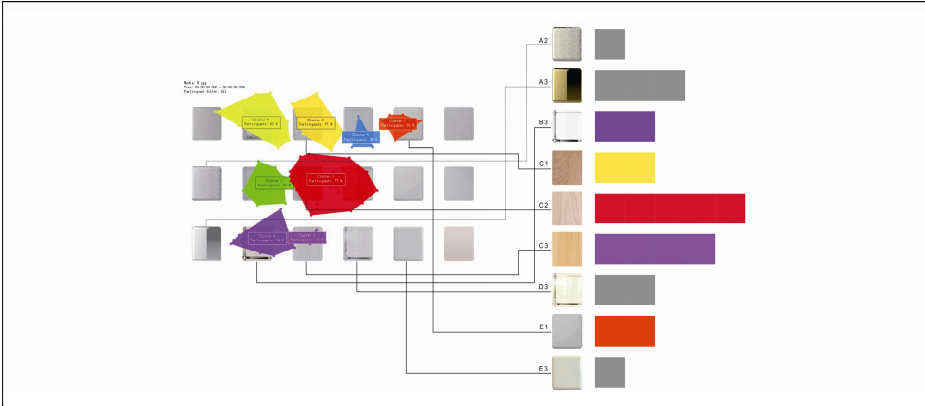


Fig. 8. Consistency between personal preference and objective attraction in material/texture






Cluster	C1	C2	B3	E1	C3
Participants (%)	77%	77%	54%	31%	23%
Consistency with Personal Preference					

Fig. 9. Consistency of texture/material between personal preference and objective attraction

**Material/Texture.** On the test of material/texture category, in fact, in order to make the test more simple and easy to the elderly. It integrated material/texture categories into one. The test content are displayed in horizontal classification, from the left to right, there are A=Steel, B=Glass, C=Wood, D=Plastic, E=Ceramic, F=Paper, and in vertical classification, from the top to the bottom, there are 1=Rough, 2=Mid-rough, 3=Smooth. Figure 8 and 9 show the statistical results that the participants preferred wood, ceramic and glass is consistency with objective attraction closely. All wood material and various textures are the most welcome to the elderly. It shows the distinct feature what close to the natural material. In addition, there is similar composition between glass and ceramics material. They are also the most common use and touch materials in their daily life.

**Pattern.** On the test of pattern category, the stimulus was setup in 6 types of pattern style that are symbolic style, realistic style, decorative style, artistic style, abstractive style and traditional style.

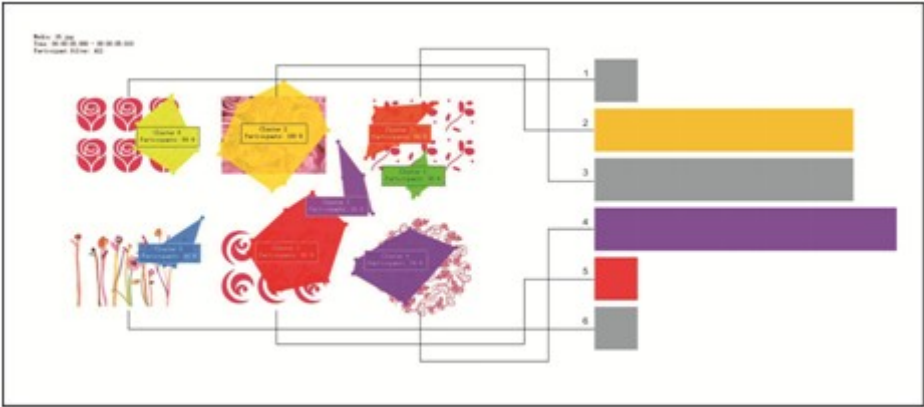


Fig. 10. Consistency between personal preference and objective attraction in pattern




Cluster	2 (Concrete)	3 (Abstract)	4 (Traditional)
Participants (%)	100%	92%	54%
Consistency with Personal Preference			

Fig. 11. Consistency of patterns between personal preference and objective attraction

Figure 10 and 11 indicate the statistical results that the participants preferred pattern are realistic style, abstractive style and traditional style, and these preferred are also consistency with objective attraction closely. The data demonstrate all of preference selected with high attention by participants. Particularly, most of participants did enjoy the traditional style even though the degree of attraction is lower than realistic style and abstractive style. It shows that the pattern with vivid, realistic style and clear, simple abstractive style is more easily sensation and distinguish to the elderly. The traditional style is related to Chinese culture and Chinese people cognition, its distinct trait comes from past emotional and cultural experience.

5 Conclusion and Recommendations

In the study, 23 participants (24 in total) with 96 percent confirmed that it can bring them pleasurable mood when visual representation is in line with the personal cognitive preference in VE, and just only 1 participant is confused and difficult to know where the pleasurable mood come from. For this purpose, the study explored to clarify the main factors of the elderly VE and their common cognitive features through data collection from personal preference and objective attention in two test tools.

Furthermore, the study successfully found these factors of consistency existed between personal subjective preferences and objective reflection with the flowing

results: i.e. 1) consistency of color are nearly cover all hue, higher purity area of coverage and brighter brightness area of coverage; 2) consistency of shape are five-petal flowers, cross star and five-pointed star; 3) consistency of material/texture are wood with all sorts of texture, ceramic with rough texture and glass with smooth texture; 4) consistency of pattern are realistic style, abstractive style and traditional style. These results proposed will contribute to further understanding the elderly real needs of experience and provide a valuable reference for improving pleasurable and satisfactory to the elderly in VE.

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