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Material Perception and Surface Properties

Tien-Rein LEE[1], Vincent SUN[1], Ming-Kang LAN[2]
[1] Center for Color Culture and Informatics, Chinese Culture University
[2] Department of Information Communications, Chinese Culture University

ABSTRACT

Color Research has developed prosperously in these years, particularly on "color appearance", which had made a significant breakthrough. Among them, textures, which are intimately related to color appearance, have got little attention. Features of textures possess enormous influences on surface color perception. Interactions between colors and surface materials have big stake on the accuracy of color display. Recently, the uprising of "material perception" researches has gradually filled up the insufficiency. The present research aims to explore the influences of material properties on the appearance of surfaces. Based on authors' previous study (Lan, Lee et al. 2015), and adopting the Cesia's theoretical model (Caivano 1996), which proposed three elements of material properties: Permeability, Absorption, and Diffusivity (P-D-A scale), with the utilization of rotary color mixer devices, in adjustment with properties combined of various ratios of mirror surfaces, matted surfaces, and transparent surfaces, we investigate each element's influences on the appearance for a variety of building materials collected through professional architects, and inspect influences of various textures on subject's psychological feelings. The aim is to build a workable Cesia scale for a series of representative building materials, and is to perform a quantitative survey on perception about material surface features in systematic ways, and to deliver results of practical data for subsequent researches on Cesia theory.

1. INTRODUCTION

Based on authors' previous research (Lan, Lee et al. 2015), in which the P-D-A scales were built for a series of rotating disks, the present study aims to measure perception of surface properties for a variety of glass samples using similar psychophysical tasks.

Professor Jose Caivano, former chairman of International Color Association (AIC), coined the term "Cesia" in an article published in the journal Color Research and Application (Caivano 1991), which suggests a system describing the visual and optical property about texture. As mentioned in the article, the system was initiated by Argentina scholar Jannello in the 1960s (Jannello 1963) as an effort to introduce texture as a feature of surface perception.

Texture, which refers to the perception about material properties of a surface, is intimately connected to color appearance but got less attention in the field of color appearance study. Features of texture possess enormous influences on the perception of color. Interactions between color and surface texture have big stake on color appearance. If we can figure out patterns of connection between texture and color, or between texture and material, it's not only beneficial to material perception research, but also can be practically applied to business commodity.

Studies demonstrate that, surface material of products directly affects sales consequences, which indicates that besides color, texture is another important factor affecting user's psychological evaluation. Texture itself is a huge research issue, and it will be bigger and intriguing when adding into color factor. There are thousand kinds of combinations as objects are composed of different colors and textures, but few researches had figured out the variation or tendencies of this phenomenon. In the present research, we intend to figure out a systematic way to evaluate the perception about visual textures.

2. METHOD

With the efforts of Dr. Caivano, Cesia has been used as an effective system to describe visual textures, which are defined as surface material perceptions, including features concerning glossiness, reflectance, and transparency. From physical measurement perspective, Cesia can be presented with light permeability and diffusivity, plus the reflectance factor, forms a three-dimensional Cesia space composed of permeability, diffusivity, and absorption. Just like color order systems, such as NCS or Munsell, Cesia is an order system describing surface perceptual characteristics.

Cesia is basically a way to describe visual perception. Under different illumination and observing conditions, different Cesia P-D-A indexes will turn out to represent different visual sensation toward surface textures (Caivano 1998). Under standard measurement conditions, Cesia data can be used as surface characteristics sensation indexes, besides a 3-D color order system, to further expand the perceptual dimensions of color (Figure 1).
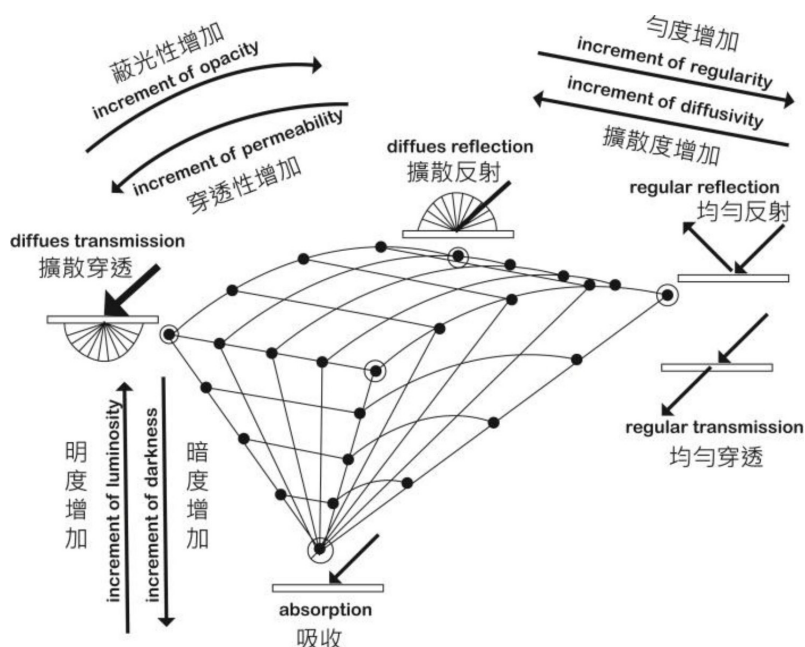

Figure 1. The solid of Cesia with the five primary sensations.

2.1 Sample Preparation

In the previous study, disks with various proportions of specular, matt white, translucency, and black surfaces were used (Figure 3). Those disks were mounted on rotary motors and were spinning at speeds high enough to form a uniform appearance. The observers were asked to rate the degree of mirror-ness, matt-ness, transparency, and blackness for designated samples respectively, with an anchoring sample for each condition. The resultant data show positive correlations, if not linear, between the physical magnitude and psychological estimations (Figure 3, Lan, Lee et al. 2015). In the present study, the samples used to be rated are 23 glass plates provided by Taiwan Glass Inc. (www.taiwanglass.com). Those glass samples have various permeability, surface reflectance, and translucency on physical scales as given by the manufacturer. They are chosen based on availability.
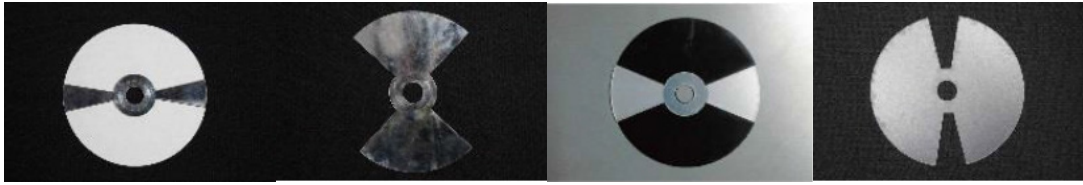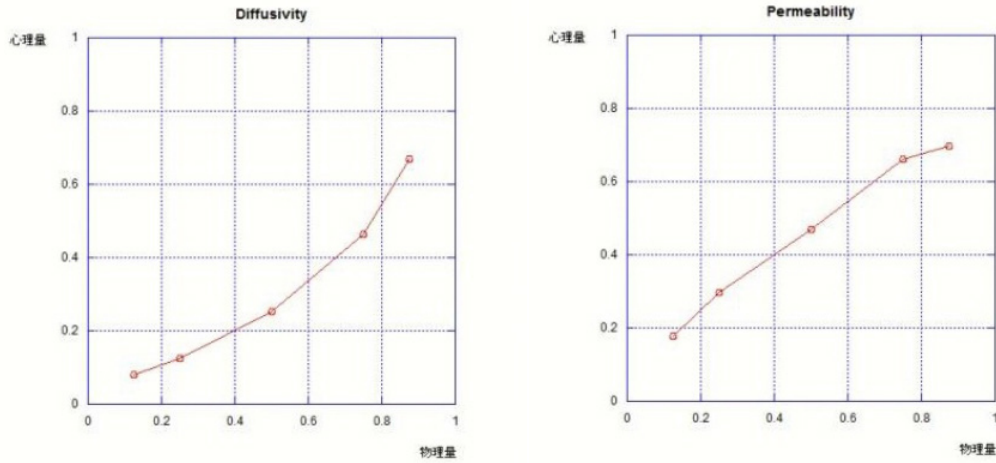
Figure 2. Disk samples used in the previous study.

*Figure 3. Permeability and Diffusivity psychophysical data
obtained in the previous study.*

2.2 Psychophysical Experiment

The experiment set-up of the present study is shown in Figure 4. The test samples (plate glass) was placed on an slanting shelf (45°), covered by an black cardboard with an 3"x3" square opening, where samples can be observed (Figure 4). Observers were instructed to rate their perceived glossiness, mirror-ness, and transparency to the samples they looked through the square opening. Two spinning disks on the right side used as anchors for minimum and maximum references.
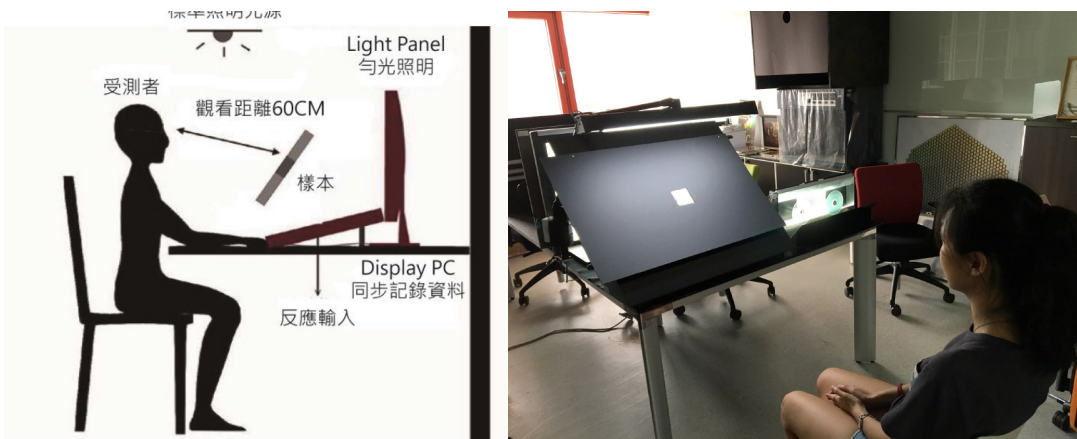

Figure 4. The experimental apparatus.

3. RESULTS AND DISCUSSION

Generally speaking, the observers showed evidence that they could understand what the terms glossiness, matt-ness, mirror-ness, translucent and transparency mean, and made correspondent and relatively consistent ratings. There are individual differences for the response among the observers. The perceived glossiness and matt-ness show near linear positive correlation with the physical ones of the samples. For transparency in the previous experiment, the observers usually felt a great amount of transparency with a small portion of slit on the spinning disk. However, this phenomenon does not present in the current study. For glass samples, the perceived transparency positively varies with the physical transmission data. The results suggest that the spinning disk paradigm should be revised and tested with more combinations for more materials.

4. CONCLUSIONS

The present study provides practical data for Cesia, on both the system and theory. The study shows that the indexes in the Cesia system are understandable for human observers, and can generate rather consistent results for Cesia indexes. The present research suggests that even for solid samples, such as the plate glasses used in experiments, Cesia is still a valid system to describe the material texture perception, and the use of spinning disks can also serve as a standard references for Cesia indexes.

ACKNOWLEDGEMENTS

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Address: Prof. Tien-Rein Lee, Center for Color Culture and Informatics,
Chinese Culture University, 55 Hwa-Kang Road, Taipei, TAIWAN
E-mails: trlee@faculty.pccu.edu.tw,csun@faculty.pccu.edu.tw