COLOR IN FOOD

Technological and Psychophysical Aspects

Edited by
José Luis Caivano
María del Pilar Buera


CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Printed in the United States of America on acid-free paper
Version Date: 20120221

International Standard Book Number: 978-1-4398-7693-0 (Hardback)

CHAPTER 2

Color and Visual Appearance in Foods

R. DANIEL LOZANO

Contents

2.1 Introduction

Since almost a decade ago, I have been involved in the study and understanding of the phenomena called *visual appearance*, which was added to the experience, almost 40 years, in subjects related to color. Color of foods—salted anchovy, beans, corned beef, noodles, apple juice, orange juice, milk sweet (*dulce de leche*), corn, apples, margarine, honey, fish, sausages, tomatoes, wheat, wine, "yerba mate," etc.—has been one of the subjects I studied while working at INTI, the National Institute of Industrial Technology, in Argentina. The present work intends to describe something more than color. In fact, it tries to establish a reasonable ground to understand a very complex phenomenon, such as the whole visual appearance, which includes color but is not restricted to it. It is well known that only three primaries are necessary to see color. We shall forget here to define which primaries we are dealing with. Presently, we accept that there are three primaries: red, green, and blue. Also, we shall not specify which these colors were. Now, when we see a texture, such as the skin of an orange or a lemon and the shell of a walnut, a peach, or a strawberry, color indicates not only the product but also the

about a much more restricted view: the way people can see, recognize, and describe colors, forms, and objects, including surface finish and texture, without any relation to other external factors as in the case of Hutchings' total appearance.

In 1978, I published a book on color measurement (Lozano 1978). After 30 years, I tried to rewrite it, but when I went into appearance measurements, such as gloss, I found plenty of information about different aspects of visual appearance never mentioned before, particularly those related to the finishing of automotive paints. Simultaneously, the development of new characteristics of computers (such as memory and velocity) and the approach of new programming techniques such as the "graphic software" and the "inverse graphic rendering," the use of fractals and wavelets, the techniques used to create movie pictures—particularly animated films for children by the companies such as DreamWorks and Pixar—and the extensive use of Fourier maths, together with the advance and research on contrast sensitivity in human vision, have completely changed the approach to visual appearance.

In a meeting of the CIE Technical Committee 1–65 on visual appearance held in Paris (CIE 2006), I presented a work with the modified proposal of a previous work (Lozano 2006, 2007) (see Figure 2.1). It is important to stress that the circle is divided into three parts as is the whole visual appearance phenomena. They are color, cesia, and spatiality. Color is the best known aspect and is composed of luminosity and chromaticity, the latter being divided into two components: hue and saturation or chroma.

Luminosity or clarity allows going further to luminous reflectance and transmittance and, from there, to whiteness. This is a part of the circle shared with cesia, which is described as the perception of the spatial distribution of light (Caivano 1991, 1993, 1994, 1996, 1997, 1999, 2001; Caivano and Doria 1997). A new component is introduced, named spatiality, which is determined by the space appreciation or evaluation through the visual system.

There are visual appearance phenomena that connect spatiality with color, such as metallic, pearlescent, or iridescent appearances in which color changes as the angle of illumination or observation does. Therefore, they are dependent on the spatial distribution of the incident and observed light. We call this group spatial color. Cesia also has three components. One is shared with color: luminosity, luminous reflectance and transmittance, clarity, and whiteness. The connection of whiteness with color is the effect called yellowness, when whiteness is modified adding a color contamination, such as yellow, a product, in most cases, of aging or deterioration.

The other two components of cesia are permeability and diffusivity. The first is related to the capacity of the material or object to absorb light. Normally, the opposite of permeability is opacity. The second is related to diffusion of light by means of scattering. Gloss (or the contrary, matt or dullness), translucency, and transparency are visual appearances related to this property.

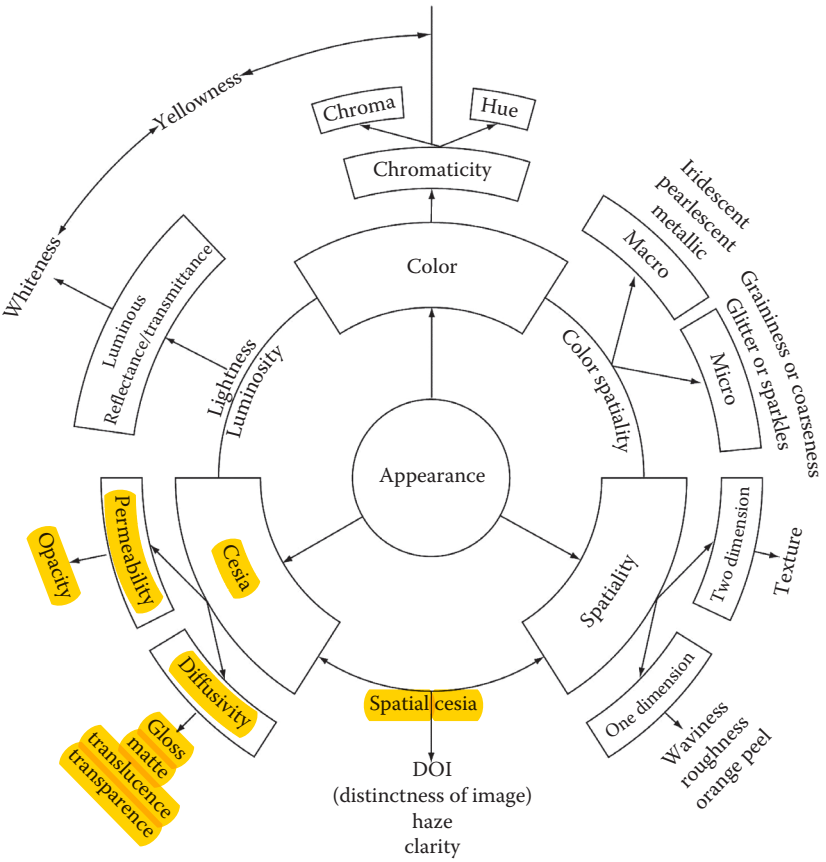

Figure 2.1 Circular scheme of visual appearance divided into three components: color, cesia, and spatiality. The intermediate components are spatial color, spatial cesia, and lightness or clarity between color and cesia.

Following down the circle, we find what is qualified as spatial cesia and which are properties of cesia based on the spatial perception of the appearance without color evaluation, such as definition of image (DOI), haze, and clarity (this is related to the perception of light diffusion in a transparent liquid). These appearances are related to cesia because they are independent of color perception and need a spatial evaluation of the visual effect. In the case of DOI, we need to observe the definition of images reflected on the surface, haze is perceived in the space around the light source reflection, and clarity is observed in the whole image of the liquid in the glass or bottle.

Then we can see the new proposal: spatiality of one and two dimensions. Why one and two dimensions? Why not three dimensions? Well, at first sight, it is difficult to explain it. When trying to catch an object, a human being uses both eyes to evaluate the distance. However, when looking at a scene, human

nothing if it is not really related to what people see. If there is no psychological and psychophysical support of the scales used in the instrument, its validity is questionable.

References

Caivano, J. L. 1991. Cesia: A system of visual signs complementing color. *Color Research and Application* 16 (4): 258–267.

Caivano, J. L. 1993. Appearance (cesia): Variables, scales, solid. *Die Farbe* 39 (1–6): 115–125.

Caivano, J. L. 1994. Appearance (cesia): Construction of scales by mean of spinning disks. *Color Research and Application* 19 (5): 351–362.

Caivano, J. L. 1996. Cesia: Its relation to color in terms of the trichromatic theory. *Die Farbe* 42 (1–3): 51–63.

Caivano, J. L. 1997. Semiotics and cesia: Meanings of the spatial distribution of light. In *Colour and Psychology, Proceedings of the AIC Interim Meeting*, ed. L. Sivik. Stockholm, Sweden: Scandinavian Colour Institute, Colour Report F50, pp. 136–140.

Caivano, J. L. 1999. Evaluation of appearance by means of color and cesia: Visual estimation and comparison with atlas samples. In *Proceedings of the AIC Midterm Meeting*. Warsaw, Poland: Central Office of Measures, pp. 85–92.

Caivano, J. L. 2001. La investigación sobre los objetos visuales desde un punto de vista semiótico, con particular énfasis en los signos visuales producidos por la luz: color y cesía. *Cuadernos—FHYCS* (Univ. Nac. Jujuy, Argentina) 17: 85–99.

Caivano, J. L. and P. Doria. 1997. An atlas of cesia with physical samples. In *AIC 1997, Proceedings of the 7th Congress*, vol. 1. Kyoto, Japan: The Color Science Association of Japan, pp. 499–502.

CIE (Commission Internationale de l'Eclairage). 2006. Technical report: A framework for the measurement of visual appearance, CIE 175. Vienna, Austria: CIE Central Bureau.

Daubechies, I. 1988. Orthonormal basis of compactly supported wavelets. *Communications on Pure and Applied Mathematics* 41 (7): 909–996.

Gabor, D. 1946. Theory of communication. *Journal of the Institute for Electrical Engineering* 93: 429–457.

Haar, A. 1910. Zur Theorie der ortogonalen Funktionen-systeme. *Mathematische Annalen* 69: 331–371.

Hunter, R. S. and R. Harold. 1987. *The Measurement of Appearance*, 3rd edn. New York: Wiley.

Hutchings, J. B. 1999. *Food Color and Appearance*, 2nd edn. Gaithersburg, MD: Aspen.

Julesz, B. 1962. Visual pattern discrimination. *IRE Transactions on Information Theory*, IT-8: 84–92.

Julesz, B. 1975. Experiments in the visual perception of texture. *Scientific American* 232: 34–43.

Julesz, B. 1981a. Non-linear and cooperative processes in texture perception. In *Theoretical Approaches in Neurobiology*, eds. T. W. Werner and E. Reichardt. Cambridge, MA: MIT Press, pp. 93–108.

Julesz, B. 1981b. A theory of preattentive texture discrimination based on first-order statistics of textons. *Biological Cybernetics* 41: 131–138.