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Colour and visual appearance in foods

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ABSTRACT

Since almost a decade I have involved myself in the study and understanding of the visual phenomena called *visual appearance*, which was added to the experience of almost 40 years in subjects related to colour, and, among other subjects, colour 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 some of the subjects which were studied while I worked at INTI. The present work deals with the intention to describe something more than colour. In fact, intents to establish a reasonable ground to understand a very complex phenomena, such as the whole visual appearance phenomena, which includes colour, but does not restrict to it. It is well known that only three primaries are necessary to see colour. We shall forget in this abstract to define which primaries are we dealing with. Presently we shall accept that they are three: one red, one green and one blue. Too, we shall not specify which were these colours. Now, when we see a texture, such as the skin of an orange or a lemon, the shell of a walnut, a peach or a strawberry, not only colour identifies the product, but the morphological characteristics of its surface and its *visual appearance.* Simply to imagine problem complexity it is sufficient to tell that up to six different orientation angles can be set up relative to the horizontal defined as 0º (90º, 60º, 30º, 0º, -30º and -60º). To this one must add what it is called *spatial frequencies*, which are the lines of different width which we recognize as "bar code" used to identify commercial products un the supermarkets paying boxes. It is supposed that only eight of these spatial frequencies are needed to identify its appearance effect. Three colours, six orientation angles and eight spatial frequencies make 144 variables, 144 possibilities. Then, the question irises the skin. If we have three different detectors in the human retina, one for each of the three colours we see... Do we have 144 different detectors systems in the retina to see form, colour and texture? Which are they? How they work?

INTRODUCTION

The problem to evaluate colour in foods is present since the human been appeared on the surface of earth, thousands of years back in history. Based on visual experience primates choose the food to eat. Colour and visual appearance in combination with other senses, help to fed themselves. Since then, the political and economical changes in the society introduced the mass production of foods. Even nowadays, people choose the products in the food shops guided by their experience. Their *total appearance* as described by Hutchings (1999) which joined all the senses in a whole perception mode including different aspects of the social life.

He describes the total appearance as formed by three parts: *receptor mechanisms*, *inherited and learned responds to specific events* and *immediate environment*. The *receptor mechanisms* are the inherited and acquired sensory characteristics such as *colour vision* (including adaptation, after-images, constancy, discrimination and metamerism), *aging effects* (cataract, glare, light intensity need and yellowing) and other senses (hearing, smell, taste and touch). The *inherited and learned responses* are: *culture, memory, preference, fashion*, and *physiological* and *psychological effects.* The *immediate environment* elements are:

geographical factors (climate, landscape and seasonal changes), *social factors* (crowding, personal space and degree of awareness), and *medical factors* (survival and need, state of well-being and protection).

The present work limits its scope to the proposal of a new mode of classification of visual appearance limited only to what the people sees, without any other consideration respect to environmental, cultural or historical background or surrounding.

A NEW CLASSIFICATION OF VISUAL APPEARANCE

As the reader can see, this approach is much more than the "simple" perception of visual appearance (including colour). For the "total" appearance" history and environment of the person who observe and evaluate the scene are pertinent. The present work will only try to describe new information about a much more restricted view. How people can see, recognize and describe colours, forms and objects, including surface termination and texture without any relation with other external factors like in the case of the total appearance.

In 1978 was published my book on colour measurement (Lozano 1978). After 30 years I tried to rewrite it, but when I got into the appearance measurements, such as gloss, I found much more 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", the "inverse graphic rendering", the employ of fractals and wavelets and the techniques used to create and describe movie pictures, particularly those animated films created for children by the firms Dreamworks and Pixar, and the extent use of Fourier maths, together with the advance and research on contrast sensitivity in human vision, have change completely the approach to visual appearance.

In a meeting of the CIE TC 1-65 Visual Appearance held in Paris, France (see CIE 2006), I presented a work with the modified proposition of a previous paper (Lozano 2006a,b) The original proposition was modified and presented is the described in Figure 1.

It is important to mark that the circle is divided in three parts as is the whole visual appearance phenomena. They are: *colour, cesia* and *spatiality*. Colour is the most known and is composed by *luminosity* and *chromaticity*, this later is also divided in two known 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 visual appearance without colour (Caivano 1991, 1993, 1994, 1996, 1997, 1999, 2001, Caivano and Doria 1997). A new component is introduced and is named *spatiality*, which is determined by the space appreciation or evaluation through the visual system.

There are visual appearance phenomena which joints the spatiality with colour, such as *metallic*, *pearlescent* or *iridescent* appearances in which as the angle of illumination or observation changes, colour also does. Therefore are dependent on the spatial distribution of the incident and observed light. We call this group *spatial colour*. Cesia has also three components. One is shared with colour: luminosity, *luminous reflectance* and *transmittance*, *clarity* and *whiteness*. The connection of whiteness with colour is the effect called *yellowness*, when whiteness is modified adding a colour contamination, such as yellow, 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 result of permeability is *opacity*. The second classification is related to diffusion of light by means of scattering. *Gloss* (or the contrary, *mat* or *dullness*), *translucency* and *transparency* are visual appearances related to this property.

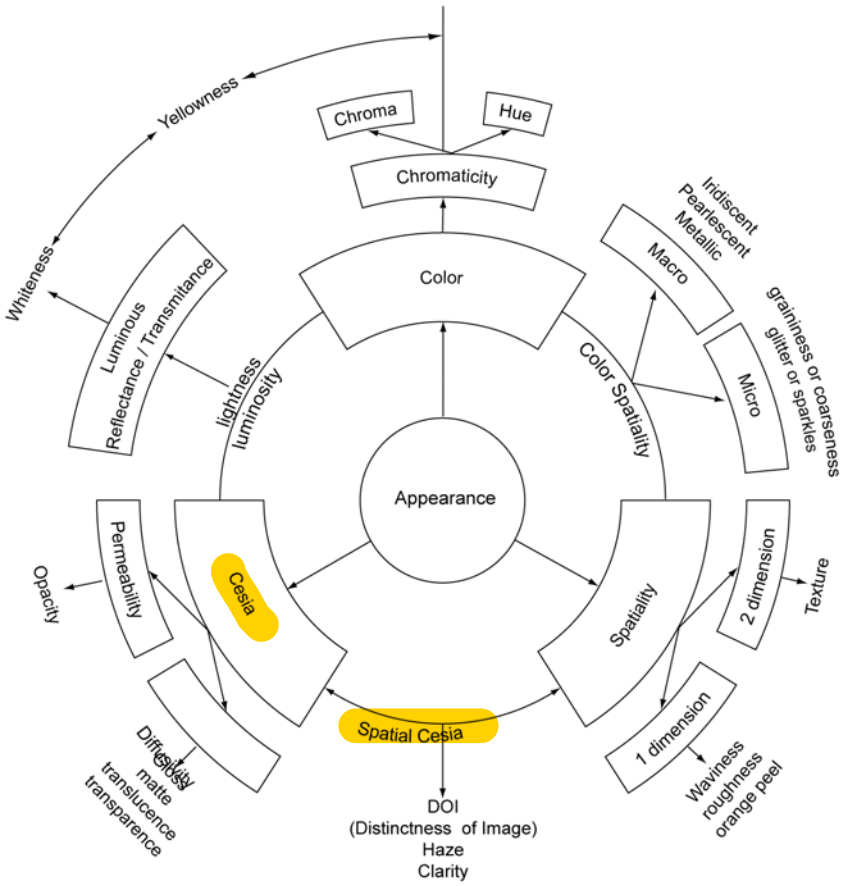

Figure 1. Circular scheme of visual appearance divided in three components: colour, cesia and spatiality. The intermediate are spatial colour, spatial cesia and lightness or clarity in between colour and cesia.

Following down the circle it is found what is qualified as *spatial cesia* which are properties of cesia dependent of the spatial perception of the appearance without colour 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 are independent of colour perception and need a spatial evaluation of the visual effect. In the case of DOI needs to observe definition of images reflected in 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 found the new proposal as *spatiality* of *one* and *two dimensions*. Why one and two dimensions? Is there no three dimensions? Well, at first sight, it is difficult to explain it. The human been when tries to catch an object with his hands, uses his two eyes to evaluate the distance, but, when is seeing an scene, he is not any longer able to calculate distances directly. He depends on the elements which composed the scene and evaluate the sizes of the objects present in it, comparing with his previous experience. He sees the scene, as in a picture or a photograph, in two dimensions and guess distances and size of these objects with respect to the surrounding ones. He is able then to evaluate the visual appearance in two dimensions.

When an observer looks in a linear mode such as a footpath covered with paving tiles which has transversal lines respect his march, the lines are discriminated if they are near, but with distance the transversal lines disappear becoming a uniform view of the surface. Instead, if the lines are in the same direction of walking, then, the lines converges in the horizon,

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