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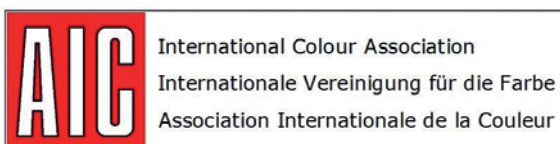
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# Chromatic Synesthesias: Effects of Color on the Perception of Different Sensorial Continua

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## ABSTRACT

The associations among different senses are known as synesthesia. This is produced when stimuli received through a certain sensory channel are perceived and interpreted as sensations of another kind. The most usual transpositions involve vision and hearing, but also taste, smell and touch. A good deal of theoreticians from the fields of psychology of perception and psychophysics have developed order systems for the stimuli or sensations affecting the five basic channels through which humans perceive and process information from the environment. Among these, color order systems are the best known. There are also models that organize visual textures, spatial shapes, and non-visual sensory continua: sounds, tactile sensations, tastes and odors. The aim of this paper is to address the concept of synesthesia, to present a survey of some models that organize sensory continua and, from their comparison, speculate about the way synesthetic transpositions that involve vision are produced.

## 1. SYNESTHESIA

Synesthesia is a phenomenon by which associations among different sensorial continua are produced. This phenomenon appears when stimuli received through one of the senses are perceived and interpreted as other kind of sensations. The study of synesthesia can be approached from psychology of perception, as well as from neurology, but it has also interested or affected plastic artists, musicians, poets, linguists, semioticians, and others (Kandinsky 1912; Sanz 1985, 1993: 180-194; van Campen and Froger 1999, 2001, 2003).

Two classes of synesthesia are usually distinguished: *genuine synesthesia* and *pseudo-synesthesia*. Genuine synesthesia appears as a neurological abnormality in a minority of persons (Cytowic 1995). Pseudo-synesthesia is considered a normal phenomenon of association produced by similitude of qualities between sensations.

There is a hypothesis that sensoriality in babies is typically synesthetic, and that when they grow their senses undergo a progressive separation, becoming more specific and tuned to certain kind of stimuli (Baron-Cohen 1996). If this were true, then an adult genuine synesthete would be a person whose sensorial channels, instead of having evolved, remained as in the initial stage. But it seems logical to think that in normal persons some vestiges from this stage could remain. The most usual synesthetic associations involve vision and hearing, but taste, smell and touch appear as well. However, vision seems to be present in most of the cases.

## 2. ORDER SYSTEMS OF SENSORIAL CONTINUA

Many theoreticians from the fields of psychology of perception, psychophysics, physiology, arts, architecture, and others, have developed order systems for the stimuli or sensations that affect the five basic channels through which humans perceive and process information from the environment: sight, hearing, taste, olfaction, and touch. Among these, color order systems

are the best known and have been developed along the whole history of color research. But there are also models that organize other perceptual variables: visual textures, spatial shapes, cesias, and non-visual sensory continua such as tactile sensations, tastes, odors, sounds, etc. (Figure 1).

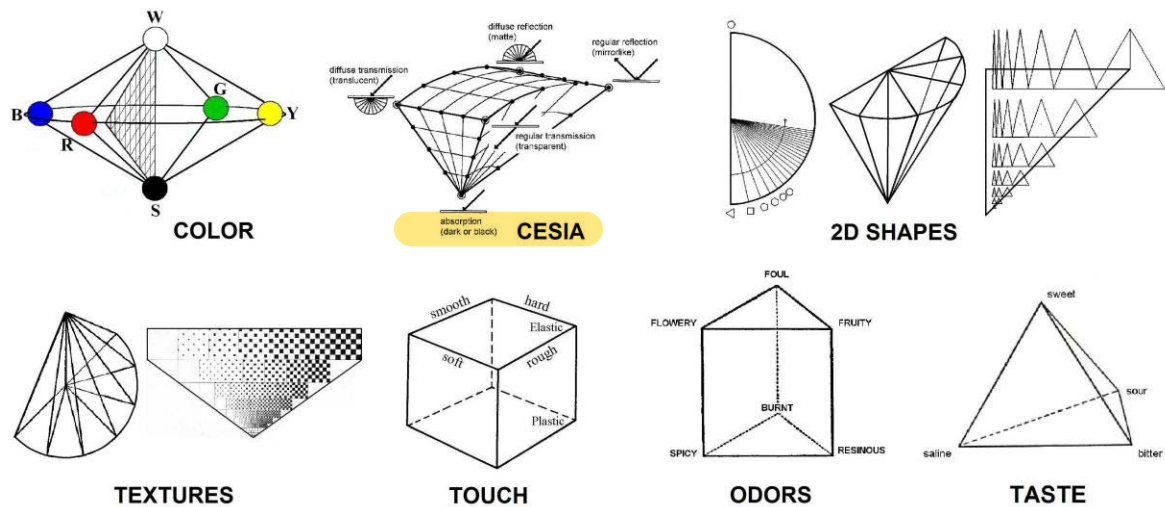


Figure 1. Order systems for different sensory continua: color (Natural Color System), cesia (Caivano), two-dimensional shapes (Jannello), visual textures (Caivano), touch sensations (Katz), odors (Henning), and taste sensations (Henning).

### 3. POSSIBLE CORRESPONDENCES

Let's now present the following hypothesis:

- ∄ If we understand synesthesia in a wide sense, as similarities among sensations of different kind that all persons can perceive (not as a neurological anomaly);
- ∄ and if the order systems for the sensory continua represent how humans perceive and organize the corresponding sensations;
- ∄ it seems plausible to find some kind of relationship between synesthesia and order systems. We could imagine particular cases of association, and verify whether they appear at a high rate in normal persons (not in clinical cases of synesthetes) or not.

After the comparison of the models, their opposite sensations and their variables, it is possible to detect certain axes of coincidence. Most of the models have a vertical axis with an opposition pair that could be associated to the “heaviness” of the sensations, a quantitative aspect:

	light - heavy
color	light - dark
cesia	light - dark
sound	high - low
shape	small - big
visual texture	small - big
odor	fruity - resinous
taste	sweet - bitter
touch sensation	soft - hard

Perpendicular to this axis, another axis often appears, which has to do with the saturation of the sensations, a quali-quantitative aspect:

	<b>saturated - unsaturated</b>
<i>color</i>	chromatic - achromatic
<b>cesia</b>	<b>regular - diffuse</b>
<i>sound</i>	pure sound - noise
<i>shape</i>	surface - line
<i>visual texture</i>	dense - sparse
<i>taste</i>	tasteful - tasteless
<i>touch sensation</i>	rough - smooth

The third variable is usually of a more qualitative nature. In some cases, instead of being a continuum between two opposite poles, it adopts a circular way, as in the chromatic circle:

<i>color</i>	<i>hue</i> (chromatic circle: yellow, red, blue, green, yellow...) (oppositions: yellow-blue; red-green)
<b>cesia</b>	<b>permeability (transparent - opaque)</b>
<i>shape</i>	<i>form-matrix</i> (triangle - circle)
<i>visual texture</i>	<i>directionality</i> (directional - non-directional)

These are just some hypothesis of the similarities that could be recognized between qualities of different sensory nature. There is probably more than this. Is it possible to verify these correspondences?

#### 4. VERIFICATION BY SURVEYS

By means of surveys or experiences with normal persons (not clinical synesthetes), we could verify whether those correspondences are shared by most people in a natural way, or change (and then new hypothesis would be needed), or are affected by other factors (sex, age, education, profession). No doubt, this is a long-term research program. Particularly, I have carried out two experiences in this direction: with color and sound, and color and shape.

In an article published in *DeSignis* (Caivano 2003) I develop the associations between color and sound, and present the results of a survey with normal persons (not genuine synesthetes) about the associations among the variables of color (hue, lightness, saturation, and spatial extension) and the variables of sound (pitch, loudness, timbre, and duration). Most of the people relate:

- pitch of sound with lightness of color,
- loudness with spatial extension of color,
- timbre of sound with hue of color,
- duration of sound with spatial extension of color.

In addition, the associations were markedly pointed out in this direction:

- low sounds with dark colors, high sounds with light colors;
- quiet sounds with small color extensions, loud sounds with big color extensions;
- noise with violet (one of the extremes of the spectrum), pure sounds with red (the other extreme of the spectrum);
- short sounds with small color extensions, long sounds with big color extensions.

In color seminars I usually test the color-shape associations supported in the Bauhaus by Kandinsky and Itten (see Itten 1970: 75-76). They asserted that:

- yellow is associated with the triangle,
- red, with the square,