

# The Effect of Color Design on Fragrance Association

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## **Abstract**

In order to effectively communicate the fragrances of commercial perfumes to consumers, it is important to apply congruent colors to their bottles and packaging. This research investigated the cross-modal associations between colors and fragrances. Through analyzing bottle colors of more than 200 popular perfumes in the market, distinguishable color design patterns were revealed in accordance with their fragrance types. In the color-fragrance matching experiment conducted in a blind setting, three test perfumes had characteristic hues. Their associated hues were similar with the real colors of the perfumes. There were significant variations in tone across fragrance notes, i.e. the top notes, middle notes, and base notes. These results support the existence of robust cross-modal associations between particular colors and fragrances in commercial perfumery by extending the use of color-odor matching task to a test population of Korean participants.

**Conference theme:** Food & Fragrance design

**Keywords:** Color, Fragrance, Commercial Perfume, Cross-modal Association

## **Introduction**

People recognize an object initially by their eyesight and then next determine its other sensory characteristics, e.g. its odor. Visual color is a particular important perceptual variable in odor identification because it evokes common mental images of objects, and these images form expectations of the odors (Sakai et al., 2005; Zellner et al., 1999). People often associate fragrance with color, preferring scents of brightly colored flowers, fruits, and spices, which conjure up the images of gardens, woodlands, and citrus groves (Chiazzari, 1998).

To date, several studies reported the existence of cross-modal associations between odors and colors at both behavioral (Gibert et al., 1996; Schifferstein, 2004) and neuro-physiological levels (Gottfried, 2003; Östernauer, 2005). Gilbert et al. (1996) found that subjects made non-random color matches to odors and that the color matches are stable over time when retested as much as 2 years later. Thirteen out of 20 test odorants (fragrance materials) had characteristic hues in the range of red-purple through green-yellow. In addition to differences in hue, significant variation in chroma and value was discovered across odors. In a follow-up study on these correspondences, Kemp and Gilbert (1997) suggested color lightness varies inversely with perceived odor intensity. Schifferstein and Tanudjaja (2004) also demonstrated the stable color-odor correspondence by performing a color-odor matching study using a set of different odorants (complex fragrances) and color chips from the Natural Color System. Recent research by Demattè et al. (2006) verified that the implicit association test (IAT), which has only been studies using unimodal visual stimuli, can be used to examine cross-modal associations involving olfactory stimuli. They found that participants responded more rapidly and accurately to odor-color pairings having a stronger association (e. g. strawberry and pink) than to those having a weaker association (e.g. spearmint and pink).

As the cross-modal correspondences between colors and odors have been proven to be consistent, fragrance companies have been interested to inform potential consumers about the smell experiences of their products through colors (Schifferstein and Tanudjaja, 2004). It is important to apply congruous colors to bottles and packages of commercial perfumes in order to effectively express the mood of the fragrance inside the bottles. For example, a light, herbal perfume would never be packaged in a hot red or dramatic black box because the sensory message would be all wrong (Hope and Walch, 1990). Accordingly, the appropriate color-odor combinations can facilitate communication between perfumes and customers and improve the appeal of the perfumes in the market.

In order to identify how colors affect the association of fragrances, this research investigated the cross-modal correspondences between scents of popular commercial perfumes and their liquid or bottle colors. In particular, these color-fragrance correspondences can be subject to variation between cultures (Ayabe-Kanamura et al., 1998; Österbauer et al., 2005). This research extends the experiment in matching complex fragrances with colors to a test population of Korean participants (vs. the North American participant by Gilbert et al., 1996; the Dutch participants by Shifferstein and Tanudjaja, 2004; the English participants by Demattè et al., 2006).

The research processes are to (1) investigate the literature on how color affects olfactory perception; (2) examine bottle colors of commercial perfumes classified into 12 scent groups; and (3) conduct a blind test on the colors evoked by smelling three different perfumes wrapped to hide the bottle colors. This paper has been sequentially organized in accordance with the results of those processes.

### **Analyzing Color Design Patterns in Commercial Perfumery**

In order to identify the relationships between colors and scents of perfumes, this research investigated more than 200 women's perfumes at Sephora.com, a leading online beauty retailer offering the finest in fragrance, cosmetics and facial skin care products.

Sephora.com offers a fragrance finder service, which helps customers find the perfect perfume based on their favorite fragrance or fragrance notes. This service recommends perfumes by referring the Fragrance Wheel developed by Michael Edwards, a renowned fragrance expert. This wheel simplifies fragrance classification into the five standard scent families, viz. floral, oriental, woody, fresh, and fougère. Hence, this research classified the women's perfumes of Sephora.com according to 12 sub-groups of the families in the wheel using the fragrance finder service function, as shown in Table 1.

The bottle colors of the perfumes were matched to color samples of the Hue and Tone 120 color system, which was developed by IRI Color Design Institute Inc. This system arranges the 110 chromatic colors and 10 achromatic colors by 10 hues (R-YR-Y-GY-G-BG-B-PB-P-RP) along the horizontal axis and 11 tones<sup>1</sup> (Vivid-Strong-Bright-Pale-Very pale- Light grayish-Light-Grayish-Dull-Deep-Dark) along the vertical axis. To compare color patterns across perfumes in

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<sup>1</sup> The tone of a color is the result of the interaction of two factors: brightness, or value, and color saturation, or chroma.

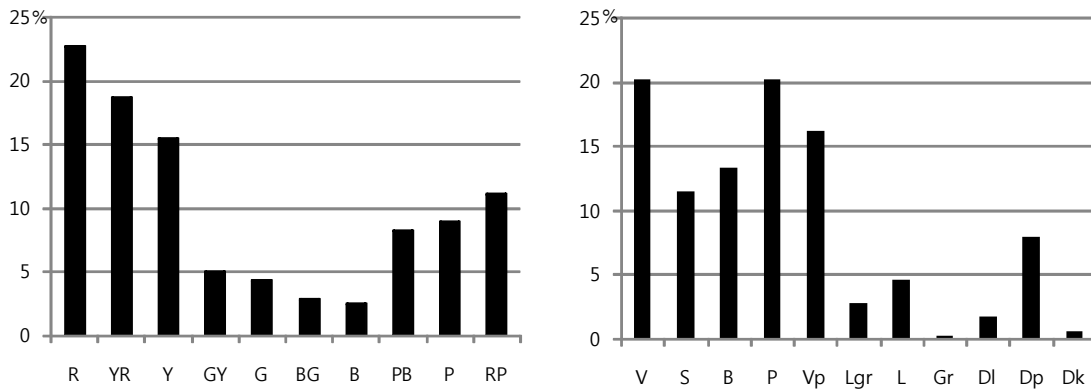
the 12 sub-groups, the perfumes were mapped in two-dimensional color space of the Hue and Tone 120 color system according to their bottle colors.

Family	Sub-groups	Major Notes	Family	Sub-groups	Major Notes
Fresh	Citrus	Zesty scents with juicy notes of lemon, mandarin, grapefruit, and other citrus oils	Floral	Floral	Elegant and feminine scents with blended notes of rose, peony, tuberose, jasmine, orchid, and lily of the valley
	Green	Sporty appealing scents with green tea leaves, green grass, fresh herbs, and vine leaves		Soft floral	Classic floral scents mixed with powdery notes of iris, vanilla or citrus
	Water	Refreshing and cooling scents with wet air, ice, and cool dew		White floral	Romantic scents mingled with pure white blossoms like jasmine, gardenia, and freesia
Oriental	Woody-oriental	Sensual scents with soft sandalwood, warm rosewood drizzled with deep, rich, potent patchouli and layered with soft blossoms and a hint of spice	Woody	Woods	Bold, classic wood notes like cedar, patchouli, pine, sandalwood, and vetiver
	Oriental	Seductive scents with spicy notes of clove, musk, and cardamom		Woody oriental	Sexy scents with blending exotic notes of sandalwood and amber and patchouli
	Floral-oriental	Sensual scents with orange flower, vanilla, white pepper, and sweet spices		Dry woods	Smoky and warm scents with think leather, tobacco and cedar wood
	Soft-oriental	Powdery, yet elegant scents with ethereal notes of incense, amber, and musk		Mossy woods	Oak moss and warm soil drizzled with a hint of energizing citrus or crisp green notes

**Table 1.** Five groups and fourteen sub-groups of fragrance notes (Source from Sephora.com: <http://www.sephora.com/browse/me/index.jhtml?categoryId=>)

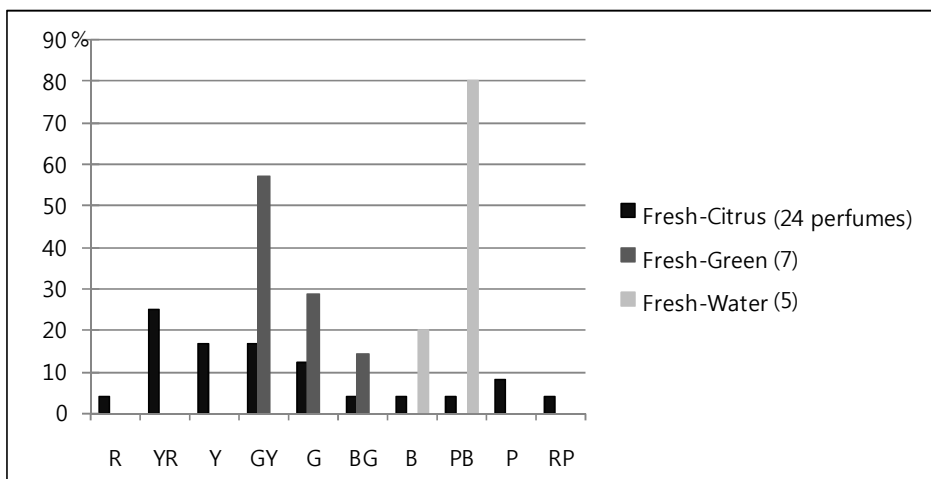
For each fragrance group, frequencies of selected colors were calculated along with frequencies of the hue and tone parameters of the selected colors. In order to examine dominant hues and tones in commercial perfumery, frequencies of the selected hues and tones were enumerated for all perfumes in the 14 sub-groups. While the selected hues covered the majority of the color spectrum, they spanned a relatively large portion in the range of red-purple through yellow. There were the lower hue matches to green-yellow, green, blue-green, and blue, as shown in the left chart of Figure 1. These results are consistent with the range of red-purple through green-yellow reported by Gilbert et al. (1996) in their seminal study on what colors people can match to odors explicitly. It can be assumed that people's intuitive and familiar color-odor correspondences may be partly reflected in the color schemes of popular female perfumes in the fragrance market. With regard to the selected tones, a relatively large portion was formed in the range of vivid (vivid and strong) and bright (bright, pale, very pale) tones (see the right chart of

Figure 1). From these distributions, it was discovered that colors that arouse strong and vivid image or light and soft image were dominantly applied to the popular female perfumes.



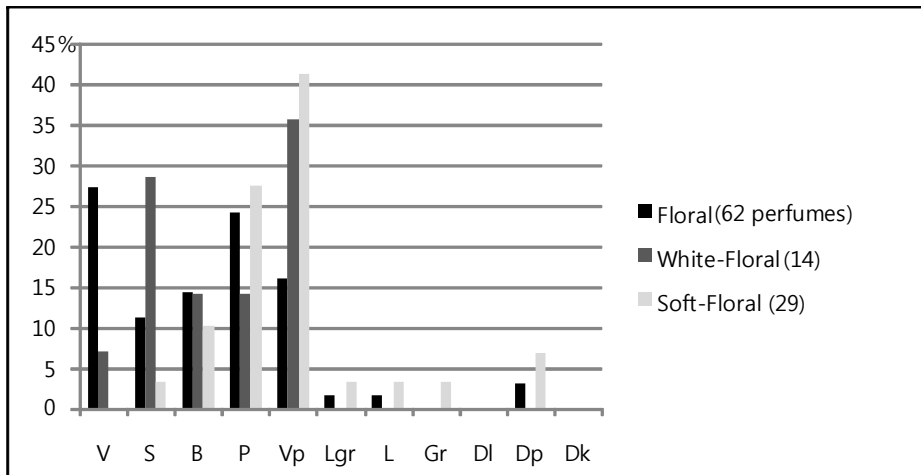
**Figure 1.** Distributions of the perfumes by hue and tone

The perfumes in the sub-groups of the fresh family have characteristic hues such as Fresh-Citrus (YR, Y, GY), Fresh-Green (GY, G), and Fresh-Water (B, PB), as shown in Figure 2. These results support that color images of major fragrance materials were applied to design the bottles of perfumes under the Fresh family. For example, “Be Delicious Charmingly Delicious” and “Be Delicious” by DKNY in the Fresh-Citrus group are colored by Yellow-Green, which is consistent with color image of American apple used as main fragrance material.



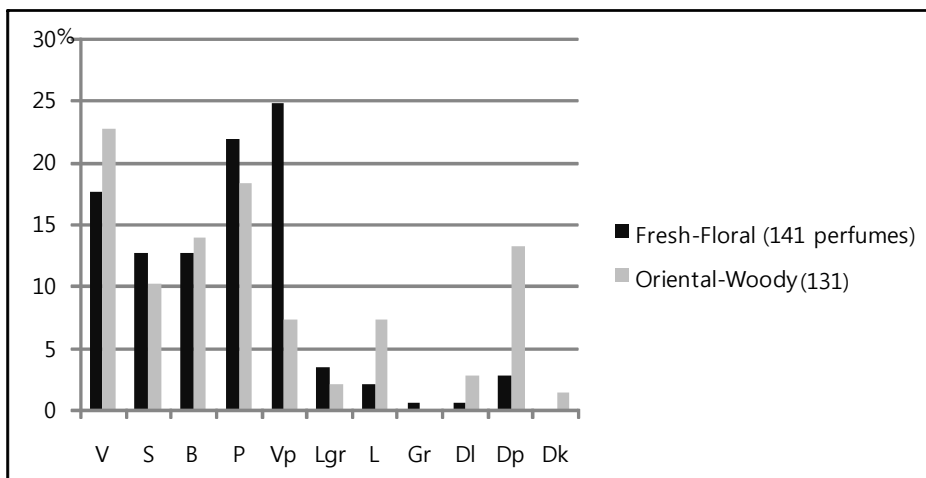
**Figure 2.** Distribution of the perfumes in the Fresh family by hue (Note: Two achromatic colored perfumes in Fresh-Citrus (1) and Fresh-Water (1) were excluded)

In the Floral family, the matching colors differed mainly by tone, and less by hue. Significant variations in tone were found (see Figure 3). Tones tend to be lighter from Floral to White-Floral and Soft-Floral. The lighter the intensity of floral scents is, the brighter the tone of their bottle colors become.



**Figure 3.** Distribution of the perfumes in the Floral family by tone (Note: Twenty achromatic colored perfumes in Floral (4), White-Floral (11), and Soft-Floral (5) were excluded)

Color tones of the perfumes across the families were compared by pairing the families in accordance with the similarity of their scent images, i.e. the Fresh-Floral families and the Oriental-Woody families. In Figure 4, the perfumes in the Fresh-Floral families are brighter in color tone than those in the Oriental-Woody families. These results were caused by the widely known color images of major fragrance materials (see Table 1) in two family groups.



**Figure 4.** Comparison of the perfume distributions by tone between the Fresh-Floral and Oriental-Woody families (Note: Thirty-five achromatic colored perfumes in Fresh-Floral (21) and Oriental-Woody (14) were excluded)

## Conducting Color-Fragrance Matching Test

### Participants




This experiment was conducted with students who were taking a “Color practice” course at Kongju University in Korea, in partial fulfillment of a course requirement. Fifty-eight students (24 males and 34 females) with a mean age of 21 years (range of 20-25 years) took part in this experiment. All the participants had a normal sense of smell with no history of olfactory dysfunction and normal or corrected-to-normal vision, as indicated by self-report. Prior to testing, all students carried out a preliminary assignment in order to cultivate knowledge on fragrances and colors of commercial perfumes. Each student investigated a commercial perfume in terms of its product concepts, colors (fragrance fluid, bottles, packaging, advertisements, and other promotional materials), fragrances (top, middle, and base notes<sup>2</sup>), and major fragrance materials. During the class, the students presented and shared the results of their research assignments before participating in the experiment. These trained students also took part in the color-fragrance matching test. All students were asked not to wear any fragrances on the test day.

### Materials

Three different bottles of perfumes were used in this experiment, viz. Subtil by Salvatore Ferragamo, Oxygene by Lanvin, and Beyond Paradise by Estée Lauder. These perfumes are located under the Floral family of the Fragrance Wheel, but each has different top, middle, and base notes. The bottle and packaging colors of the tested perfumes are different, as illustrated in Table 2. Colors of major fragrance materials, which are mixed in the three perfumes, are identical with those of the perfume bottles and packages. The visual stimuli consisted of 120 colors defined by the Hue and Tone 120 color system. The 120 numbered color samples were printed on high-quality A4-sized papers.

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<sup>2</sup> Perfumes are dynamic and change over time, and evaporate at different speeds: the fast-evaporating ones are called the “top notes,” the medium-fast ones the “middle notes,” and the slowest the “base note” (Chiazzari, 1998, p. 70).

Perfume	Subtil	Oxygene	Beyond paradise
Bottle and Packaging			
Color	Strong Red	Bright Blue	Rainbow
Scent	Floral family: fruity, floral scent	Floral family: soft, feminine, refreshing, floral scent	Floral family: light, sweet, floral scent
Fragrance Materials	<ul style="list-style-type: none"> <li>· Top notes: <b>cherries</b> and <b>orange flower water</b></li> <li>· Middle notes: water fruits, lily of the valley, and <b>red lily tulip</b></li> <li>· Base notes: jasmine and musk</li> </ul>	<ul style="list-style-type: none"> <li>· Top notes: <b>blue iris</b>, gardenia, and white sandalwood</li> <li>· Middle and Base notes: hyssop, <b>blue-flowered plant</b>, white musk, and white pepper</li> </ul>	<ul style="list-style-type: none"> <li>· Top notes: Eden's mist, <b>blue hyacinth</b>, <b>orange flower</b>, templar, and jabuticaba fruit</li> <li>· Middle notes: laelia orchid, crepe jasmine, mohania japonica, and <b>pink honeysuckle</b></li> <li>· Base notes: natal plum blossoms, ambrette seed, zebrano wood, and <b>golden melaleuca bank</b></li> </ul>

**Table 2.** The three perfumes used in the experiment (Note: Words in bold type= fragrance materials whose colors are similar with their perfume bottles or packaging)

### Procedure

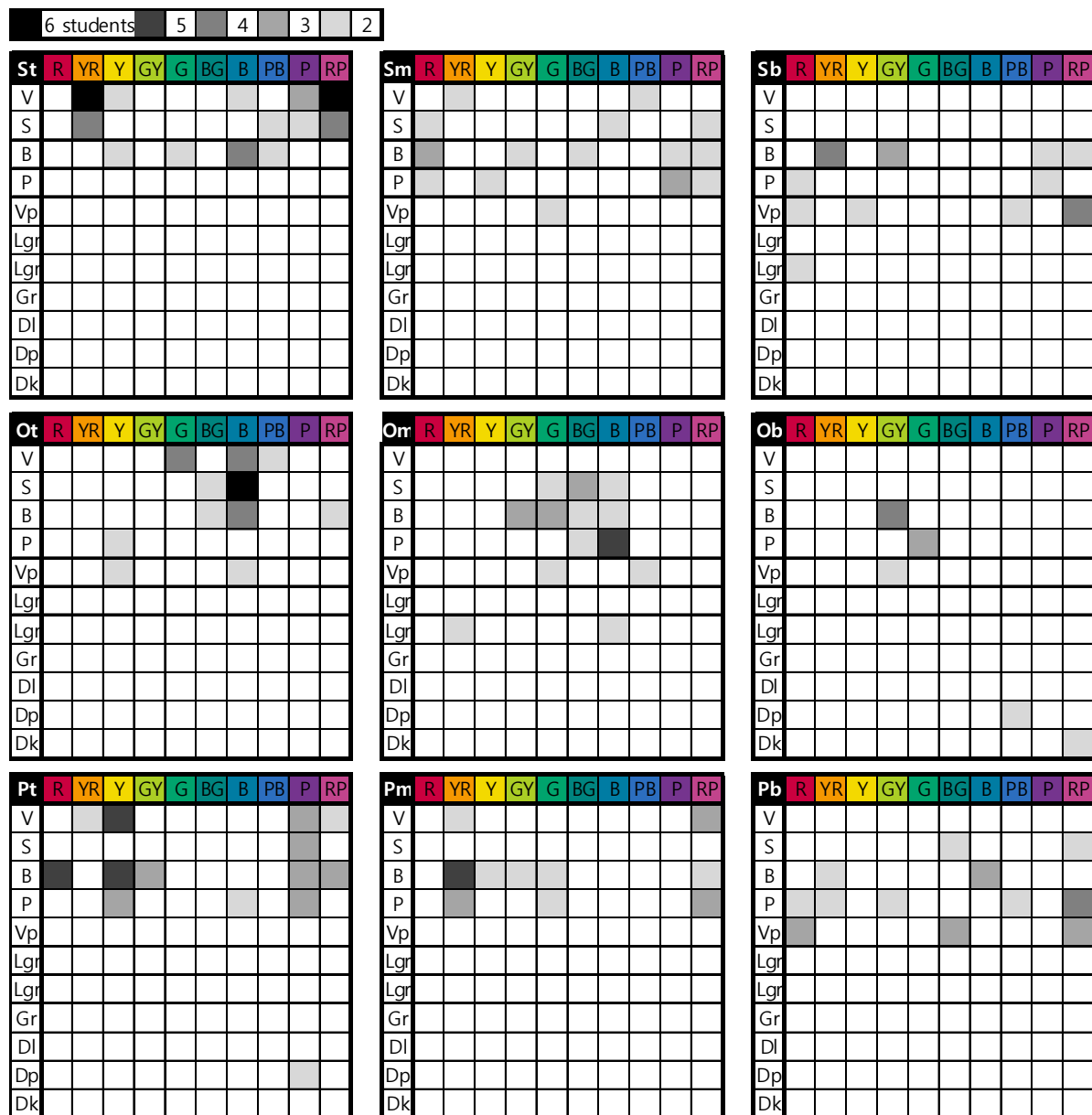
The three test perfumes were surreptitiously wrapped to hide the bottle colors. A 2cm x 10cm piece of white, odorless paper was distributed to the students. The smallest possible amount of fragrance was sprayed on the paper by pressing the nozzle of the perfume bottle shortly. The students shook the sprayed papers in front of their noses for the task of discerning the scents of the test perfumes. Immediately after smelling the perfume, the students were instructed to imagine which color would fit with that perfume, and then select the associated colors from the Hue and Tone 120 color system printed on the paper. They were given time to examine all the color samples. The students were also requested to smell the papers three times with time intervals of 0 minute, 2 minutes, and 30 minutes, in order to match colors with the top, middle, and base notes. In general, scents of middle note appear from two minutes to one hour after the application of a perfume. On the other hand, compounds of base note class are typically rich and deep and are usually not perceived until 30 minutes after the application of the perfume or during the period of perfume dry-down (Wikipedia, retrieved in 2008). In order to minimize any possible carryover effect from the presentation of the perfumes, the inter-stimulus interval



was set at 30 minutes. During interval time, the test room was ventilated and the previous test papers were put away.

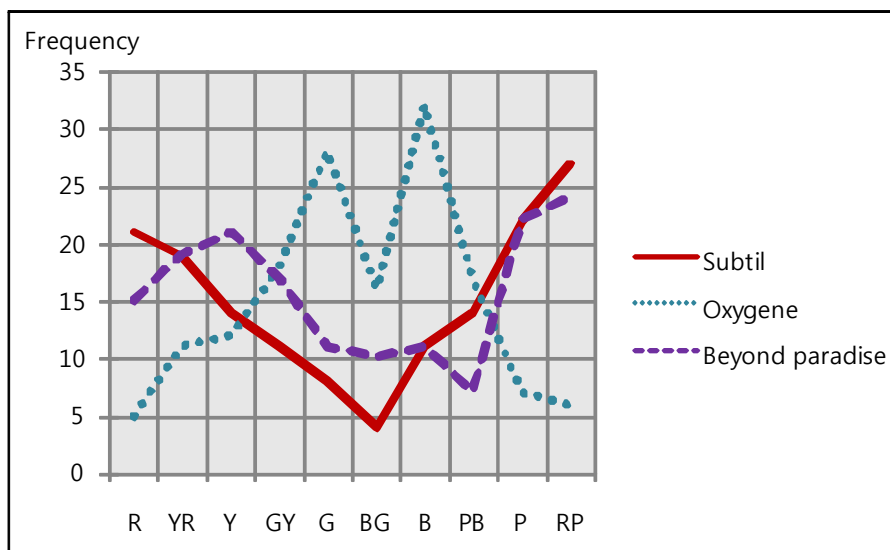
### Results

In order to compare the color selections across the three fragrance stimuli, the selected frequencies of each color sample were calculated for each perfume. On the Hue and Tone 120 color system, positions of the selected colors were filled by five grayscale colors according to their frequencies, except for the colors that were chosen just by one student (see Figure 5). The hue and tone parameters of the selected colors were identified and their frequencies also were counted respectively. Several distinguishable patterns were found in hue across perfumes and in tone across three note types.



**Figure 5.** Visualizing the frequencies of colors selected for the three notes of each perfume (Note: S- subtil, O- Oxegene, B- Beyond paradice, t- top notes, m- middle notes, and b- base notes)

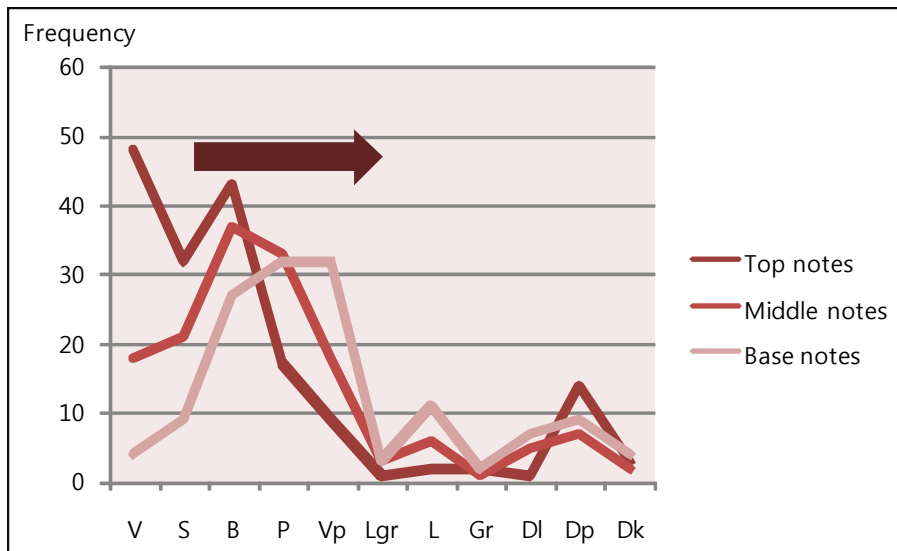
The hue frequencies of the colors that were matched with all notes of each perfume were summed up and compared across perfumes, as shown in Figure 6. The color matches showed greater variation in hue across perfumes. Interestingly, the dominant hue ranges were similar with the real bottle colors of the perfumes: Subtil ( P-RP-R-YR), Oxygene (G, B) and Beyond paradise (Y, P-RP). When students were sniffing the perfumes, they could imagine familiar objects that have similar scents and then recall the colors of the objects; therefore, the students could easily guess the real colors of the perfumes because the colors of the tested perfumes were largely influenced by those of their major fragrance materials (see Table 2).



**Figure 6.** Comparison of the hues matched with all notes of each perfume

Top notes consist of small, light molecules that evaporate quickly. The compounds that contribute to top notes are strong in scent, very volatile, and evaporate quickly. Contrary to the top notes, middle and base notes consist of larger, heavier molecules that evaporate more slowly. Base notes bring depth and solidity to a perfume (Wikipedia, retrieved in 2008). In accordance with these differences in three notes, patterns of color tones were investigated across fragrance notes after totalling frequencies of three perfumes for each tone. Significant variations in tone were discovered across fragrance notes as shown in Figure 7.

Colors in highly vivid tones were chosen most often for the top notes, while those in more pale tones were selected for the base notes. The results suggest that slowest-evaporating, base notes were associated with lighter colors. Therefore, it can be claimed that the cross-model relationship between vision and olfaction appears to be dimensional because color tone varies with the speed of perceived fragrance notes.



**Figure 7.** Comparison of the tones matched with each note of three perfumes

## Discussion and Conclusions

Color is a visual feature with a particularly strong influence on odor perception (Östernauer, 2005). In order to facilitate communications about the perfumes in the market, this research investigated these associations for the real perfumes, which consist of complex fragrance materials and have three fragrance notes. Another difference of this research was the extension of participants to Korean students. Based on results of this research, a number of findings about the cross-modal associations between colors and fragrances can be summarized in the following results:

Firstly, majority of the commercial perfumes spanned a relatively large portion in the range of vivid and bright tones as well as RP, R, YR, and Y hues. The noteworthy color design patterns across fragrances imply that people's common color-odor pairing patterns do partly influence on the visualizing perfumes. Several color-fragrance correspondences were so compelling that perfume bottle colors were chosen in accordance with color images of its major fragrance material (e.g., perfumes in the Fresh-Citrus, Fresh-Green, and Fresh-Water groups). The intensity of fragrances has also strong relationships with color tones of their perfume bottles (e.g., Floral, White-Floral, and Soft-Floral groups).

Secondly, the results of the color-fragrance matching test proved a reliable multi-sensory interaction between olfaction and vision across perfumes like the results of the previous color-odor matching tests conducted in other countries. Consumers easily identify fragrances of

perfumes whose colors have stronger associations with color images of their fragrance materials. For example, the selected hues for Subtil were PR, P, and YR and these colors were similar with the color images of its major fragrance materials such as cherries, orange flower water, and red lily tulips. The associated color tones of the perfumes vary systemically with the speed of the perceived fragrance notes. The slowest-evaporating base notes were matched with lighter color tones, compared to the fast-evaporating top notes. Just like the emotional responses to colors in strong tones, the scents of top notes are usually fresh, assertive, or sharp because these notes form a consumer's initial impression of the perfume.

Finally, the consumers' smell experiences can be strongly influenced by what colors their eyes see. When a color fits a fragrance, their color combination communicates a coherent message and is likely to be regarded as a unitary whole (Schifferstein, 2004). Therefore, the appropriate color-fragrance combinations enhance consumers' preferences to the perfumes and can influence their purchase intentions by providing coherent, robust emotional messages and experiences. This research can help designers create color palettes for the liquid, bottle, packaging, and ads of perfumes that express the mood of their fragrances. It also provides comparative design strategies based on multi-sensory interactions between vision and olfaction to companies that have difficulties in conveying emotional messaging about their perfumes in the competitive fragrance industry.

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