

Does chromatic lightness have an impact on the perceived odor of Brazilian perfumes?

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ABSTRACT

This paper presents results of experiments carried out between 2013 and 2016, in which we searched for correspondences between the olfactory stimuli of perfumes and the visual stimuli of their primary packaging. In the present study, we explore a potential correlation between colors and smells. The chosen methodology consisted of analyzing colors from two different points of view: first, how companies use colors to represent smells; and second, how consumers perceive fragrances and how they correlate them to colors. We called these two approaches the 'representation of colors' and the 'perception of colors.' Our method also entailed searching online for catalogs of fragrance companies and selecting those that use colors associated with fragrance families. In order to investigate the consumer's perception, we carried out sensorial experiments in which a group of people performed a blind analysis of four Brazilian perfumes. Quantitative and qualitative explorations were conducted. Basic statistics were used that confirmed companies' practices. The research results concluded that consumers not only associate specific colors to fragrances, but they may associate the lightness of a color to the intensity of a fragrance. For example, participants of the experiments perceived a fragrance as softer attributing the softness to the lighter colors of the packaging. The results presented in this paper could be useful for designers and marketers because they highlight the importance of the correspondences between the senses, as well as the correlation between color and odor intensity.

KEYWORDS Perfume, Color, Brazil, Perception, Packaging

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1. Introduction

This study inquires into the role of design in the perfumery industry, in particular into the impact of color and shape upon fragrances. A multisensory approach in the field of Perfume Packaging Design was used, with focus on the hypothesis that potential associations between smell, colors and shapes exist. The experiments on the correspondence between visual and olfactory stimuli of perfumes were carried out between 2013 and 2016 (Silva 2017). Two types of experiments were conducted exploring the representation of smells and the perception of smells.

We know that verbalizing a smell is not an easy task. For those working in the fragrance market, however, it becomes a necessity. Our research has been encouraged by literature describing research employing a multisensory approach (Demattè et al. 2006, Gilbert et al. 1996, Hanson-Vaux et al. 2013, Joutsela 2010, Kim 2008, Moeran 2011, Spector and Maurer 2012).

Joutsela (2010) supports the idea that different sensory stimuli must be used in packaging design in order to impact the consumer on multiple levels. In the present research concerning perfumes, it is crucial that elements such as shape and colors be in synergy with the sensations that the fragrances supposedly evoke. As previously discussed (Silva and Mazzilli 2016), research in the field of experimental psychology also shows that a consonance between stimuli can enhance one's perception and consequently the communication.

Gilbert et al. (1996), a group of researchers from Givaudan-Roure Fragrances Company, performed an experiment in order to find correspondences between vision and olfaction. Participants of their experiment were asked to associate odor stimuli with Munsell color chips. Beyond the correspondences found, the researchers identified a potential relationship between color lightness and odor intensities. Based on these results, we selected a group of colors considering lightness variation. Demattè et al. (2006) from the Department of Experimental Psychology at the University of Oxford in England confirmed the correspondences previously verified by Gilbert et al. (1996). The researchers from Oxford suggested that the establishment of such associations comes from people's lived experiences. Based on this, we decided to combine questions including both visual responses (color chips) and verbal responses (words).

Another experiment on the correspondences between colors and odors was carried out by researchers from the Department of Psychology, Neuroscience, and Behavior at McMaster University in Canada (Spector and Maurer 2012), which helped us shape our own experiment. For

example, we instructed participants not to identify odors, but to smell them and give a visual response that best matched. We also asked participants about the difficulty of establishing such sensory relations and if that association made any sense. To do so, we used the Likert Scale to score responses along a range from 1 to 7 specifying the level of agreement or disagreement.

Regarding research on perfumery, we refer to the work of Kim (2008) and Moeran (2011) that most influenced this research. Both discuss the relationship between colors and odors (fragrances). Morean (2011) investigated, moreover, how fragrances are verbalized. Their research reinforces the relevance of relatively stable correspondences between fragrance, colors, shapes and words.

Finally, the research results at University of Oxford found correspondences between shapes (angular versus rounded) and odors (Hanson-Vaux et al. 2013). In that experiment, participants were asked to associate odors used in wine production with shapes. As part of the results, lemon and cedar odors were associated with the angular shapes and violet and vanilla with the rounded shapes. These results make us wonder whether perfumes that contain such ingredients could be associated to these same forms. Could the citrus perfume be associated with angular shapes? What about floral perfumes? Could they be associated with rounded shapes?

As far as perfume packaging is concerned, we expect it to express the effects that the fragrance in question intends to evoke. Furthermore, the packaging designer should be knowledgeable about the effects of smells and the meanings people attribute to them in order to effectively represent them visually and thus establish a good communication with the consumer. Multisensory research on perfumery packaging design in Brazil is still in its early stages. This paper consists of an initial and exploratory discussion.

1.1. Multisensory approach and synesthesia

Although synesthesia is related to the multisensory approach that we propose in this paper, our approach does not refer to neurologically based, genuine synesthesia (Domino 2009:599), which is a clinical picture being involuntary, constant and consistent, rather it relates to a cross-modal experience (Demattè et al. 2006, Domino 2009, Ramachandran and Hubbard 2001), also called cognitive synesthesia or commonly defined as pseudo-synesthesia (Sanz and Schindler 2010). According to Sean Day (2016)—who in 1992 established an international e-mail forum on synesthesia and in 2016 helped form the International Association of Synaesthetes, Artists, and Scientists (IASAS)—there are at least

seventy-three different types of synesthesias. Those categories related to the sense of sight are the most representative. In a survey of 1,143 genuine synesthetes, it was found that more than half of them (61.26%) experienced a grapheme-color synesthesia, in which a letter or number triggered the perception of a color. The percentage decreases, however, when it comes to the phenomenon in which smell stimulates vision. According to Day, odor-vision synesthesia corresponds only to 6.13%. Individuals with odor-color synaesthesia experience color sensations when they smell odors (Speed and Majid 2018).

Nevertheless, research in the field of neuroscience has also described and investigated sensory features in one modality that are associated with sensory features of another modality. Encouraged by these cross-modal correspondences, we decided to explore possible associations of smells with colors and shapes.

1.2. The sense of smell

Smell is a sensation that manifests itself through the sense of smell and is essential for the survival of humans and other living species. This is an important sense, e.g., for recognizing relatives, searching for a readily reproducible mate, or for locating food. However, smelling abilities have been declining over time in favor of the senses of vision and hearing. As with Jonathan H. Turner (2018:97), the evolution of mammal's biological structure has converted them from 'an olfactory-dominant to a visual-dominant animal'.

As stated by the Brazilian communication and semiotics professor Lucia Santaella, although the senses mix with each other, the complexity of human physiology imposes a sort of hierarchy between the senses. 'There is a clear decreasing degree of complexity that goes from sight to hearing, to touch, to smell, and to taste' (Santaella 2005:73). According to her, while the first three senses react to physical stimuli, smell and taste react to chemical stimuli. Vision would be more connected to the brain and to the perceptive act than olfaction. Furthermore, by developing language and writing, humans distanced themselves from animals using much less the sense of smell as a means of communication.

Despite this, smells can unconsciously influence humans and their personal and societal relationships. Scientists found that under the influence of past experiences, a smell can arouse positive or negative emotions or memories. As with Wolfe et al. (2012:420), an odour usually smells good when it is familiar and bad when it is unfamiliar. These scientists believe that, when something smells bad, we tend to repel it because we rate it as dangerous. Otherwise, a good smell can evoke memories or

associations that have a positive emotional value, e.g., inviting us to approach a potential partner.

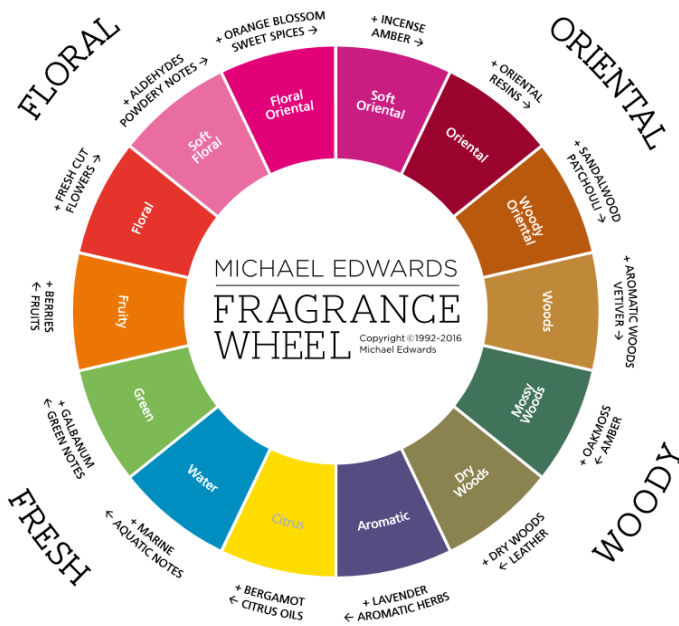
In our daily lives, nonetheless, smells are fundamental. Our smelling abilities are innate and correlated with the other senses. Through the complex interrelationship of all the senses, we succeed in understanding reality: 'Thought itself is intersemiotic and this quality is materialized in languages and their hybridization' (Plaza 1987:30). Our study is based on the premise that the correspondences between the senses are complex and need to be further explored by collecting data on the correlation of smell and vision.

1.3. Perfumery industry and the contribution of color

This paper addresses fragrance-color correspondences applied to perfume packaging. On the interface between basic needs and subjective desires, perfumes exert special power over men and women. For example, we do not depend on scents for basic and daily hygiene, but most of the personal care products include fragrance ingredients.

Brazil has a large perfumery market that has been considered as one of the largest consumer markets in the world (Armstrong 2017). Given this context, we explore perfumes and their powerful potential to communicate by the means of packaging design. It is known that the first contact of the consumer with a perfume is through its packaging. At the moment of purchasing a fragrance the subjective choice is decisive. Thus, the product designer must understand olfactory stimuli in order to be able to translate them into a persuasive and attractive visual language.

We have chosen two features of what we consider the most important elements of the visual language of perfume packaging: colors and shapes. The present paper, however, focuses on the associations of perfume with color only. In perfumery, colors play a substantial role in catalogs of fragrance suppliers to distinguish the different olfactory groups and types of ingredients. In the perfumery industry the use of a fragrance wheel is now a common practice to classify fragrances. The diagram (Fig. 1) by the British fragrance historian and taxonomist Michael Edwards (b. 1943) is 'one of the world's most comprehensive references for commercial fragrances, simplifying the classification process and showing relationships among fragrance families' (Donna 2014:28). It shows the relationships among four main olfactory groups (floral, oriental, woody and fresh), whereby neighboring circle sectors imply to share similar olfactory characteristics. The four perfumes selected for our experiments belong to each of these main groups.



By investigating the colors used by fragrance companies and suppliers, we have identified a trend in selecting a range of analogous colors to represent certain fragrance families. We selected eight representative companies from France, Spain, Italy, Switzerland, USA and Brazil. We also selected the olfactory families they used in common. From saved images and screen captures of the companies' websites, we selected colors using the color capture tool (dropper) of Adobe Illustrator software. We then elaborated a comparative table of the colors used by the different companies as presented in Figure 2. These results were the basis for investigating people's perception of colors and perfumes through the sensory experiments described in the next section. What kind of colors would best represent specific fragrances?

Fig. 1. Colors representing the olfactory families in the fragrance wheel by perfume historian and taxonomist Michael Edwards.

	Citrus	Floral	Woody	Oriental [1]	Amber	Tobacco	Spices	Animal
Albert Vieille (France)								
Euro Fragrance (Spain)								
Farotti (Italy)								
FAV 105 (Brazil)								
Firmenich (Switzerland)								
Givaudan (Switzerland)								
IFF (USA)								
Mane Fragrances (France) ...								

Fig. 2. Colors used by perfumery companies (horizontal rows) to represent some of the olfactory families (vertical rows).

2. Correspondences between vision and olfaction: sensory experiments

During the months of January and March 2015, we performed sensorial experiments in the Laboratory of Sensory Analysis of the Faculty of Pharmaceutical Sciences of the University of São Paulo (FCF/USP). The experiment consisted in the investigation of the relationship that the participants would establish between a fragrance from a blind olfactory stimulation and a color

chosen from a randomly organized color range. In order to study four different olfactory stimuli, we selected four commercially marketed perfume products belonging to the citrus, floral, woody and oriental olfactory families.

Furthermore, we prioritized the investigation for each of the four olfactory stimuli. For this purpose, we divided the research into eight sessions of experiments, subdivided into two groups. Group 1 collected associations of smells with colors and Group 2 collected associations of smells

with perfume bottle and cap shapes. The present study concerns only Group 1. Given the exploratory nature of the research, we worked with a convenient sampling. Given the location of the Laboratory in the University of São Paulo's Chemistry Complex, the majority of university students being from biological and exact sciences might have influenced the quality of the sample. We had the voluntary involvement of 345 participants, including undergraduate and graduate students, as well as USP staff and visitors. Importantly, this research did not delimit any specific audience. There was no intention through the samples to reflect data of a specific population.

We summoned the participants through a poster placed in the building of the Faculty of Pharmaceutical Sciences, on the same day as the experiments took place. As inclusion criteria, we considered fit healthy subjects over eighteen with normal color vision and smell, i.e., they should neither have color blindness nor anosmia (complete or partial loss of smell). As exclusion criteria, we did not accept people with a clinical condition compromising their sense of smell (e.g. flu, rhinitis, and sinusitis) or vision (e.g. conjunctivitis). There were no volunteers with this picture. Regarding color vision, despite the claim of normality, we applied a Color Blindness Test before the experiment. Even if we identified abnormalities, the participant could proceed with the experiment. Participants who were identified as colorblind had their data recorded but it was not included in the analysis. Finally, the experiments presented a minimal risk to the participants, since we used perfumes regularly marketed in Brazil.

The perfumes selected for analysis belong to the company O Boticário, because of its popularity and geographical coverage. It is noteworthy to emphasize, however, that the company neither participated in this research nor collaborated in the development of the present work. All the perfumes had the same concentration of cologne deodorant. We based our research on the descriptions that the company provides on its official website as selection criteria. We selected Free perfume to represent the citrus family; Floratta in Rose, to represent the floral family; Malbec Duo, to represent the woody family; and Coffee Man Seduction, to represent the oriental family. In order to test the participant's color associations with these four perfumes (Group 1), we designed a chart with 39 randomly distributed colors.

2.1. Fragrance characteristics

Fragrance companies commonly use two ways to describe a perfume. They describe its ingredients and how they are organized. These are known as the olfactory notes of a perfume. They also use verbal metaphors to suggest what the fragrance in question may evoke on consumers. With regard to the olfactory notes of a perfume, fragrances are

divided into starting or top notes (the first to be perceived), which are the most volatile, followed by body or heart notes, which embody the perfume, and finally the base or base notes, which as its name suggests, is the base of a fragrance. These last ones are notes of greater weight and durability. Concerning the metaphors, it is common to find advertising discourses indicating specific consumer behaviors, male or female gender, situations of use, and sensations these fragrances may elicit.

The citrus perfume, Free, has in its composition the ingredients: bergamot, lemon, orange, juniper and lavender as top notes; geranium, jasmine, carnation, pine, sage and sagebrush as heart notes; oakmoss, cedar, vetiver and musk as base notes. In its advertising, the company correlates the citrus or fresh top notes to a sense of freedom and energy. The base of woody notes is associated to a discreet touch of sensuality. The fragrance is also associated to the sensation of joy, enthusiasm, refreshment, independence and positivity.

The floral perfume, Floratta in Rose, has in its composition the ingredients: orange blossom, lime, yellow fruits and orchid headspace [2] as top notes; blue rose living, fresh rose, otto natural rose, ylang and gardenia as heart notes; musk accord and woody notes as base notes. According to the company's advertising discourse, this perfume is indicated for charming women. Floratta in Rose is defined as a delicate, feminine and romantic fragrance.

The woody perfume, Malbec Duo, has in its composition the ingredients: bergamot, persian lime, lemon, violet leaves, fig, plum, star fruit, rose pepper, cardomom and saffron as top notes; rose, iris, geranium, malbec headspace, chocolate note, cassis and oak as heart notes; and cedar, vetiver, patchouli, amber, moss and musk as base notes. Malbec Duo was launched as a special edition in 2011 on the occasion of Father's Day and, according to the company, due to sales success the perfume was maintained until 2016 (O Boticário 2014, O Boticário 2016). According to fragrance specialist Renata Aschar (Brasil Essencia 2019), Malbec Duo was created for powerful and naturally sophisticated men who wish to provoke, conquer and make their mark. Moreover, according to her, it is 'sophisticated and intense like a good wine'.

The oriental perfume, Coffee Man Seduction, has in its composition the ingredients: bergamot, mandarin brazil, apple and nutmeg as top notes; muguet, jasmin, cedar and sandalwood as heart notes; and patchouli, amber, musk, vanilla and gourmand as base notes. This perfume is defined as striking and engaging. It is destined for men. The company suggests that this perfume evokes a unique sensory experience, due to the contrasting combination of fruity notes and warm woody and oriental notes

harmonized by an exclusive extract of Arabica coffee and liqueur notes.

2.2. Correspondences between colors and smells

One of the multisensory research studies that most attracted our attention and interest was the one entitled 'The Effect of Color Design on Fragrance Association' (Kim 2008). The study conducted by the Korean researcher Yu-Jin Kim investigated the relationship between different colors and the intensities of fragrances. Based on her experimental results, Kim confirmed interactions between vision and olfaction in perfumery. She tested over 200 fragrances. The associations obtained between colors and fragrances in her experiments were based on the real color of the perfumes. Kim analyzed each fragrance in three stages in order to capture the best results: top notes, heart (middle) notes, and base notes. The time intervals set for the experiments were '0 minute, 2 minutes, and 30 minutes' (Kim 2008). For the analysis the consumer received a color scale that varied in hues and shades. As a result, Kim observed that the base notes, which were less volatile, were associated with lighter shades of colors than the volatile top notes. Kim argued that the appropriate combination of fragrances and colors elevated the consumers' interest in perfumes and even influenced their buying decisions.

In this paper we decided to investigate the first impact of a fragrance and the associations that it evokes. We discuss the method, material and part of the results obtained in the experiments carried out with Group 1, i.e., the experiments with smells associated to colors. Unlike Kim (2008), we did not set a time limit. Each participant could take as long as he or she deemed necessary. The average time was 20 minutes to answer the entire questionnaire, with the initial minutes dedicated to the fragrance experimentation.

In Group 1, each participant was asked what color (only one) would best represent the fragrance (Question 1). We asked the participant to state the degree of difficulty in establishing such an association (Question 2) and how much this association makes sense (Question 3). The participant was also asked to state the degree of familiarity with the stimuli (fragrance) (Question 4) and what the fragrance reminds him/her or if he/she is familiar with (Question 5). Finally, we asked each participant to associate the fragrance with words: Question 6 allowed an open answer. In Question 7 the participant should freely select one of twenty predefined words.

In each session, the participant went through four steps:

Step 1 - Initial Contact: Basic instructions on the topic of sensory analysis were provided to stakeholders who volunteered at the lab door. After agreeing to participate,

we sent the candidates to one of the seven booths of the Sensory Analysis Laboratory located at FCF/USP.

Step 2 - Informed Consent (IC): Once accommodated in the booth, the participant received two copies of the IC, to read and sign. They could choose to keep one copy with them.

Step 3 - Preliminary Questionnaire: The participant received a questionnaire (habits and personal data) with seven questions. In addition, those who participated in Group 1 also underwent a simplified vision test (6 cards) adapted from Dr. Shinobu Ishihara's original book (Ishihara 1972:4).

Step 4 - Sensory Analysis: Participants received an olfactory strip with the fragrance to be tested and the questionnaire. In addition, each participant of Group 1 received a color chart.

The color chart (Fig. 3) with 39 randomly distributed colors presented to the participants in Step 4 consisted of colors based on the CMY color wheel (Fig. 4). We selected primary, secondary and tertiary colors to compose the main group of 12 hues, which we called the 'main' colors. Then, varying by 50% towards white, we defined a second group of 12 colors as 'light' tones (inner circle). Again, varying the main group by 50% percent towards black, we defined a third group of 12 colors as 'dark' tones (outer circle). In Figure 5, we list the 36 colors in a table and added three neutral colors (white, gray and black). We grouped the colors in two different ways. The vertical rows show the value (lightness) variation (light, main and dark) and the horizontal rows show five groups of hue variation. Finally, we assigned each color a three-digit identification number generated by a randomization program.



Fig. 3. The color chart with 39 randomly distributed colors presented to the participants.



Fig. 4. Three concentric color circles based on 12 hues located on the middle circle and numbered 1 (primary colors), 2 (secondary colors) and 3 (tertiary colors). Variations of these 12 hues called here 'main' colors are the 'light' tones (inner circle) and the 'dark' tones (outer circle).

Ranges of colors	Light tones	Main colors	Dark tones
Range 1 Bluish	983	681	486
	503	910	230
	638	713	576
Range 2 Pink and lilaceous	864	524	186
	499	101	995
	321	970	459
Range 3 Yellowish to reddish	874	889	976
	663	307	123
	764	512	624
Range 4 Greenish	515	751	483
	431	425	903
	725	508	817
Range 5 Neutrals	863	192	741

Fig. 5. Colors listed, but randomly presented to the participants, together with the questionnaire.

3. Results and discussion: experiments with colors and smells

In the experiments with colors and smells (Group 1), we obtained 175 volunteers for all four fragrances. Each fragrance was separately tested in four sessions, one per day. We did not control the frequency of each participant, admitting, therefore, the possibility of participating in all four sessions. The results of the simplified color vision test indicated a suspicion of color blindness in the case of two participants. Therefore, we are considering for this discussion only 173 participants: 42 participants for citrus fragrance; 41 for floral fragrance; 45 for woody fragrance; and 45 for oriental fragrance.

In Group 1, the main purpose was to identify if the colors mentioned by the participants would match those used by fragrance companies. The first question posed was "What color best matches the fragrance you smelled?" Responses pointed not only to recurrent hues, as we can see for citrus and floral fragrances (Table 1), but to recurrent tones (Table 2).

	Citrus	Floral	Woody	Oriental
Range 1 Bluish	10%	5%	25%	23%
Range 2 Pink and lilaceous	13%	53%	20%	30%
Range 3 Yellowish to reddish	20%	23%	33%	20%
Range 4 Greenish	58%	18%	20%	23%
Range 5 Neutrals	0%	3%	3%	5%
	100%	100%	100%	100%

Table 1. Hue families associated with each fragrance.

	Citrus	Floral	Woody	Oriental
Light tones	37,5%	70%	32,5%	62,5%
Main colors	32,5%	25%	15%	15%
Dark tones	30%	5%	52,5%	22,5%
Total	100%	100%	100%	100%

Table 2. Main colors and tones associated with each fragrance.

These results induced us to inquire into why the tones would have any relation with fragrances. Then we decided to correlate the responses to Question 1 with the answers of Questions 6 and 7. In Question 6, participants had to freely associate one to three words to the fragrance that best matched the tested fragrance. In Question 7, participants were required to select as many words as they wished from twenty predefined words that best described the tested fragrance. Considering the fact that naming a smell is not an easy task (Wolfe et al. 2012), we selected five categories usually associated to fragrances when verbalizing the experiences. These five categories were subdivided into twenty words: gender (1. female; 2. male); olfactory family (3. woody; 4. citrus; 5. floral; 6. oriental; 7. fruity); fragrance intensity (8. strong; 9. mild); temporality (10. young; 11. old); and synesthesias (12. dry; 13. wet; 14. hot; 15. fresh; 16. sour; 17. oily; 18. bitter; 19. sweet; 20. spicy).

The results show that participants who mentioned a light tone in Question 1, also attributed 'mild' to the test perfume in Question 7. We deduced that a potential correspondence between color lightness and odor

intensity might exist. Taking this into consideration, we selected all the answers of the participants, in which the word 'mild' was mentioned. The following discussion considers 74 out of a total of 173 answers: 12 participants associated mild with the citrus fragrance; 22 with the floral fragrance; 16 with the woody fragrance; and, 24 with the oriental fragrance. In order to protect personal data of the participants, we assigned to each participant a number preceded by the letter 'N' (Number). For example, to show the 12 results of the citrus fragrance analysis, the first participant is identified with N1, the second with N2, and so on until N12.

3.1. Chromatic lightness and odor intensity

3.1.1. Citrus fragrance

In the experiment, 6 out of 12 participants who attributed the mildness quality to the citrus fragrance also associated light tones as the best match (Fig. 6). These are N3, N4, N5, N8, N9 and N10, which corresponds to 50% of relationships matching lightness with mildness. The result increases to 83.33% when considering the four attributions to the main colors (N1, N2, N6 and N7).

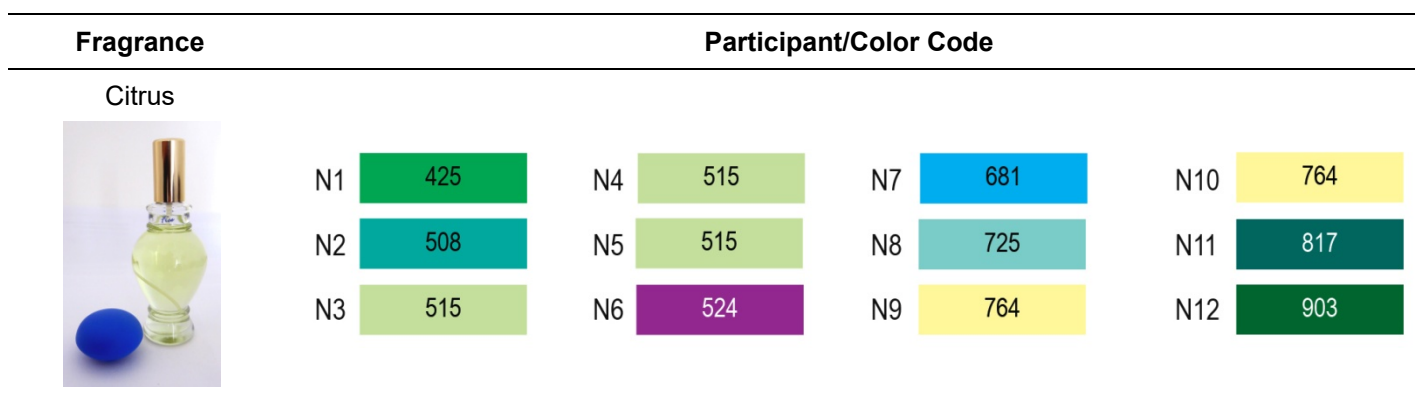


Fig. 6. Colors associated to the citrus fragrance when it was perceived as mild.

3.1.2. Floral fragrance

In the experiment, 15 out of 22 participants who attributed the mildness quality to the floral fragrance also designated light tones as the best match (Fig. 7). These include N3, N4, N6, N7, N8, N9, N10, N12, N14, N15, N16, N17, N18, N20 and N21. Moreover, one participant (N19) appointed

white as best match, despite not being a hue in itself, because white represents one of the extremes of the value scale. However, in this analysis white is considered a light tone. Taking all this into account, 72% of relationships matched lightness with mildness. The percentage increased to 90.90% when considering the four attributions to the main colors (N1, N5, N11 and N22).


Fragrance		Participant/Color Code							
	Floral	N1	101	N7	499	N13	624	N19	863
	N2	186	N8	499	N14	663	N20	864	
	N3	321	N9	499	N15	663	N21	864	
	N4	321	N10	503	N16	725	N22	889	
	N5	425	N11	508	N17	725			
	N6	431	N12	515	N18	764			

Fig. 7. Colors associated to the floral fragrance when it was perceived as mild.

3.1.3. Woody fragrance

In the experiment, 8 of 16 participants who attributed the mildness quality to the woody fragrance also indicated that a light tone is the best match (Fig. 8). These are N4, N5,

N6, N9, N10, N12, N15 and N16, which correspond to 50% of relationships matching lightness with mildness. The percentage is further increased to 68.75% when considering the three attributions to the main colors (N1, N8 and N13).


Fragrance		Participant/Color Code							
	Woody	N1	101	N5	321	N9	515	N13	713
	N2	186	N6	431	N10	515	N14	817	
	N3	230	N7	459	N11	576	N15	864	
	N4	321	N8	512	N12	663	N16	983	

Fig. 8. Colors associated to the woody fragrance when it was perceived as mild.

3.1.4. Oriental fragrance

In the experiment, 16 out of 24 participants who attributed the mildness quality to the oriental fragrance also declared a light tone as the best match (Fig. 9). These are N1, N2, N3, N4, N5, N6, N8, N9, N10, N12, N14, N16, N17, N19 and N21. Similarly, as in the experiment with floral

fragrance, one participant (N20) appointed white as best match to the oriental fragrance. Taking all this into account, 67% of relationships matched lightness with mildness. The percentage increases to 83.33% when considering the four attributions to the main colors (N13, N14, N22 and N23).


Fragrance	Participant/Color Code							
 Oriental	N1	321	N7	486	N13	713	N19	764
	N2	321	N8	499	N14	725	N20	863
	N3	321	N9	499	N15	681	N21	864
	N4	321	N10	515	N16	725	N22	889
	N5	321	N11	624	N17	725	N23	970
	N6	431	N12	663	N18	741	N24	995

Fig. 9. Colors associated to the oriental fragrance when it was perceived as mild.

3.2. Discussion: representation versus perception

The results of our experiment show that light tones were mostly attributed to the floral fragrance (72%), second to the oriental fragrance (67%) and equally to the citrus and woody fragrances (50%). By adding the main colors to the light tones, the top result still remains the floral fragrance (90.90%), followed by the oriental and citrus fragrances (83.33%), and last is the woody fragrance (68.75%). Conclusively, we can say that a floral fragrance is mainly perceived as mild and mostly associated with light tones.

By analyzing the colors associated with the four fragrances we can suppose that the perceived odor intensity may also influence the color choice for perfume bottles. If we have a unified perception of the world, it makes sense to think that people correlate the mildness quality of an odor with the mildness (lightness) of a color. This is somehow in line with what the researchers Gilbert et al. (1996) pointed out regarding the correspondences between softness and lightness identified in their experiment with odors.

Concerning the use of colors in perfume bottles we noticed a low correspondence among the colors chosen by the participants to represent the woody and oriental perfumes. Their primary packaging (perfume bottles) is a very dark color (black for woody and black coffee brown for oriental). Indeed, we did not present to the participants the same dark colors as used on these packaging. There were other options of dark colors they could choose, but the participants of our experiment perceived the possible use of light colors (50% for woody and 67% for oriental). As well, the hue families chosen by the participants do not match those used in the packaging. We infer that packaging designers may have chosen the colors associated with the main ingredients of the oriental fragrance (coffee) and woody fragrance (wood and wine). We could also infer that these colors were selected by the designers so as to communicate the sensations the

company wished to elicit, that is, sophistication and masculinity. According to psychological and historical color studies, darker colors are usually associated to men, luxury and sophistication (Heller 2013, Pastoureau 2011).

The visual representation of a fragrance can serve different purposes (Silva 2012). The colors of a perfume packaging might relate to the brand, the concept companies want to convey, the ingredients that compose the fragrances or even the effects those fragrances might have on people. It can be a combination of all these elements as well. Although we know that the perception of a smell varies from person to person, the results presented here point to the relationship that a color can have with the perceived intensity of a perfume.

4. Final considerations

These research results show how important it is to confront the visual representations already existing in a product category with the perception of consumers, especially when it comes to fragrance products with complex formulations such as perfumes. It is a market practice to classify perfumes into olfactory families. However, within the same olfactory family we can find different nuances of smells. In the same way, we should consider colors. Designers should avoid a cursory glance at the color field. As observed from the experiments, it is possible that the dimensions of value (lightness) and chroma (saturation) exert more influence on a person's perception than color itself (hue). Therefore, while dealing with the psychological effects of color, one should consider the science of color with greater depth and not just color as a set of words to which certain attributes are associated. From then on, the designer would expand the possibilities of visual expression and multisensory correspondences.

5. Conflict of interest declaration

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Notes

[1] For the oriental family we also consider the categories of amber, tobacco, spices and animal. According to Osmoz—share your fragrances, a social platform for fragrance and perfume consumers—'oriental compositions draw their richness and sophistication from precious substances such as amber, resin, tobacco, spices, exotic woods and animal notes' (Osmoz 2019a).

[2] According to Osmoz (2019b), headspace is an extraction method. It is a technique that 'allows for preserving the flower's delicacy and rarity'.

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