The Sounds of Freshness: Soundtracks that crossmodally correspond with sensations associated to olfactory freshness

Cantu, Monique Alves Frazon[1*a]; Rodriguez, Brayan[2a]; Reinoso-Carvalho, Felipe[3a]; Reyes, Luis H.[2]; Pereira, Vanessa Jaqueline De Almeida Ribas[1]; Veiga, Cesar Antônio[1]; dos Santos, Larissa Carmona Zonta[1]; Oliveira, Camila Flávia Schettino[1]; Firmino, Ana Raquel Inácio[1]; Sasson, Clarice Scliar[1]

1 Grupo Boticário – São José dos Pinhais, Paraná, Brazil

2 Universidad de los Andes, School of Engineering, Bogotá, Colombia

3 Universidad de los Andes, School of Management, Bogotá, Colombia

*Monique Alves Frazon Cantu, Curitiba, Paraná, Brazil, +55 41 984346811, moniquef@grupoboticario.com.br

[a]Co-first authors

Abstract

Background: It is well-known that positive emotions and sensations increase the impact of the product and further engage consumers. The cosmetic industry should be actively participating in this discussion, to continue innovating, and while providing the positive emotional impact that consumers seem to be looking for (i.e., well-being, mindfulness). Based on these motivations, we designed a methodology which facilitates the characterization of soundtracks that crossmodally correspond with particular sensations associated to a particular cosmetic experience (in this case, freshness in fragrances).

Methods: First, we explored the scientific crossmodal correspondences literature between sensations associated with the experience of freshness across multiple contexts, including sounds. Next, we conducted two online experiments to validate how certain sounds chosen based on those correspondences could elicit sensations and emotions associated with freshness perception. Here, participants rated sensations and odor notes while listening to these sounds.

Results: The obtained results confirmed that specific sounds were associated as expected. For instance, participants rated sounds in which predominant musical features included woodwind and piano instruments, low tempo, and legato articulation, as triggering more sensations associated with freshness (i.e., humidity, outdoors, lightness, smoothness, coolness, calmness, freshness, fruitiness, green and blue color matching).

Conclusion: These results can motivate the cosmetics industry looking for augmenting freshness sensations to consider soundscape during product experience of the customer journey and marketing strategies. Therefore, this study provides insights when it comes to connecting with consumers in innovative ways, while also disrupting on the existing needs of the beauty industry (i.e., triggering feel-good factors).

Keywords: sound; freshness; crossmodal correspondences; sensations; olfaction

Introduction.

Industry and organizations should be updated on consumer needs and desires, as we move towards post-pandemic times. Experiences and products that consider sensations and emotions as part of their experience should contribute to generate a more profound connection and enhance consumer enchantment. Moreover, adding value to the experience of consumers through different channels can breakdown physical barriers.

The cosmetic industry should be actively participating in this discussion. In order to continue innovating, and while providing the positive emotional impact that consumers seem to be looking for (i.e., well-being, mindfulness). It is well-known that positive emotions and sensations increase the impact of the product and further engage consumers.

Based on these motivations, we designed a methodology which facilitates the characterization of sounds that crossmodally correspond with particular sensations associated to a freshness experience in fragrances. Furthermore, we aim to identify the conveyance ability in the context of such sensations. In brief, this study aims to establish the musical features and values that may enhance the attributes of the perception of olfactory freshness.

Hereafter, the exploration of semantic, sensory, and emotional parameters associated with the experience of freshness that crossmodally correspond with auditory parameters in the existing scientific literature is documented.

The sensation of freshness

The exploration of freshness concepts in personal care and cleaning products industries is still scarce (compared to food and beverage). For instance, on dishwashing liquids, whose freshness expectation has found to be usually associated with cleaning power, a previous study found that peppermint and bergamot lemon odors, as well as light green colors, were considered fresher stimuli than other odors and colors in such product category's experience [1]. Patchouli and almond odors, as well as purple and dark brown colors, were considered the least fresh stimuli. In this context, olfaction dominated the judgments of freshness over vision cues (i.e., color).

In general, concerning cosmetic products, their ability to penetrate the skin across time, odor stimulations, temperature change, oily residue, and spreadability, are usually the principal factors when assessing the experienced freshness in consumers [2, 3]. Related research on perfumery has focused on looking for the odor descriptors that people associate with a fresh concept. Here, it has been found that citrusy, clear, leafy, minty, watery, floral-green, blue, fruity, light, aldehyde, together with materials with a low substantivity, tend to be perceived as fresher or refreshing [4, 5]. Conversely, powdery, high sweet, erogenic, animal, and oriental are descriptors associated with opposite sensations to freshness (i.e., warmth). The latter seems to be because higher substantivity odors are easily retained by the skin and, thus, tend to be higher perceived in hot weather.

As exposed above, consumers tend to associate multiple semantic and sensory parameters with the experience of freshness across a range of products. When it comes to cosmetics, olfaction, touch, and vision seem to be the key sensory drivers of a fresher experience. Interestingly, fresh fragrances have also been associated with particular sounds, although this kind of research is far scarcer. For example, fragrances classified as fresh, according to an ancient classification [6] (i.e., citrus, green, water), were mapped to mid-high pitch piano keys [7]. More recently, researchers found that the sounds of nature, such as sea and rain, were associated with freshness experiences related to fragrances [8]. Therefore, when assessing sensory interactions between what we hear and the experienced freshness in fragrances, we decided to use the rationale of crossmodal correspondences as a baseline.

Moving on to assessing crossmodal correspondences related to freshness, we started by mapping those attributes associated with the experience of freshness (i.e., temperature, color, smells) and how such attributes may ultimately be associated with sounds. Like this, we would be able to produce or characterize sounds that people would tend to associate with specific attributes related to the experience of freshness (i.e., temperature sensations, aromas, colors, natural scenery, and even feelings/emotions).

Concerning temperature sensations, low temperature (0-10ºC) has found to usually match with low arousal and mid-low valence emotions, such as blue/uninspired, dull/bored, and passive/quiet [10]. In another study, a winter visual cue matched with mint, moderate wind, and cooling in virtual reality stimulations [11]. Likewise, low arousal also tends to correspond with chamomile-roman odor [12] and blue color [13].

Previous research has also demonstrated that blue color can be well represented with piano sounds and green color with woodwind instruments sounds (i.e., flute, clarinet, bassoon) [14, 15]. In fact, these associations have been reported to improve artwork appreciation by people with visual impairments [14].

Light and cool color variants (in contrast to dark and warm) seem to crossmodally correspond with lemon and caramel scents, respectively [16]. Vanilla, violet, and blackberry odors are consistently associated with mid-high-pitched notes, while lemon and candied orange aromas with high pitches. Blackberry, apricot, raspberry, vanilla, and candied orange odors match more with particular instruments such as piano and often also woodwind instruments [17–19]; vanilla odor has also been found to correspond with low temperatures and thick silhouettes, and both it and raspberry aroma with pleasantness, low intensity, and round shapes [20–22]. Fruity, soft/light, and cool scents were associated by people from different countries with nature sounds (e.g., sea, rain, waves, wind, breeze) and calm/soft music [23]. Interestingly, whereas lemon smell, as citrusy, has been classified as a fresh odor, previous studies have demonstrated that it has also been associated with non-fresh concepts, such as summer weather visual cues [11], spiky shapes, unpleasantness, and high-intense smell [20, 22].

To sum up, Table 1 introduces a framework showing proven associations related to temperature (low), emotions (low arousal), colors (green, blue), flavors (mint), and smell (fruity, lemon, mint, cool, light), in which people tend to consistently match with the sensory experience of freshness across a wide variety of products. As shown above, these features can also derive into sound parameters, such as timbres (woodwind, piano), tempo (low), pitch (mid-high), mood (calm, soft), as well as naturalistic soundscaping (nature, breeze, sea, wind, rain).

Table 1. Summary of sensory and emotional associations that people tend to consistently match with the sensory experience of freshness.

Freshness dimension	**Sensation associated with freshness**	**Chemosensory sensation associated with freshness**	**Visual sensation associated with freshness**	**Semantic context associated with freshness**	**Auditory sensation associated with freshness**
Temperature	Low temperature			Low arousal	
Emotional	Low arousal	Roman chamomile			Low tempo
Visual	Green color				Clarinet, bassoon, flute
	Blue color	Musk and sea salt scent, blue-berry flavor		Calm, dependability	Piano
Flavor	Peppermint flavor				Piano, high pitch
Olfaction	Fruity smell	Raspberry, vanilla	Rounded shapes, thick silhouettes	Pleasantness, low intense, coldness	Piano, woodwind, high-pitch, mid-pitch, nature sounds
	Lemon smell		Spiky shapes, thin body silhouettes	Summer, unpleasantness, intense, feminine	Woodwind
	Cooling mint scent	Eucalyptus, peppermint	Spiky shapes, thin body silhouettes	Winter, coldness, high arousal	High pitch
	Cool scent				Breeze, sea, wind, rain sounds
	Light scent				Sea, rain, calm, soft sounds

Materials and Methods.

Experiment 1: Two hundred and sixty-four Colombian participants joined Experiment 1 (gender-balanced). They were all over 18 years old (average = 21 years; SD = 4.4). In this experiment, two categories of freshness and one contrasting category were built while classifying the auditory stimuli (see Table 1 for a summary of the classification framework). For both freshness categories, the sounds were chosen mainly relying on their low tempo, mid-high pitch, dominant legato articulation, calm/soft mood, while intended to evoke low-arousal emotions. Three of these sounds also included naturalistic soundscaping. The main difference across the two categories of freshness was the color that they intended to represent (i.e., blue or green), which also was associated with the musical instrument's timbre (green color: dominant woodwind instruments timbre; blue color: dominant piano timbre).

Concerning the contrasting category, the sounds were chosen mainly relying on genres from tropical/warm areas, high tempo, dominant strings or brass instruments timbre, dominant staccato articulation, and intended to evoke high-arousal emotions and a high degree of sensuality.

The sounds also aimed to represent a somewhat variety of rhythms and had no vocals. In total, fifteen sounds between 45 and 60 seconds in length were selected as the auditory stimuli of this experiment: five green-fresh (GF), five blue-fresh (BF), and five non-fresh (NF). Refer to Table A, in the Annex, for links to listen to all sounds and corresponding codes referred in Results section.

Procedure

Experiment 1's survey was designed on https://www.qualtrics.com to last for approximately 10 min. Participants that agreed to join the study, providing their informed consent, were instructed to always use headphones.

During the main experiment, the participants were told they would hear a sound and were instructed to carefully think about it. They listened to one sound from each of the three within-participants experimental conditions presented in random order. While listening to each sound, they were asked to describe how it made them feel, rating eight environmental, emotional, and physical sensations presented across bipolar scales. Afterwards, the participants also had to rate to what extent each sound evoked each of eight olfactory notes (see Measures section for a more detailed explanation of the dependent variables).

Measures

In Experiment 1, two main dimensions of dependent variables were assessed: sensations and olfactory notes. Concerning sensations, eight environmental, emotional, and physical dimensions were evaluated based on the abovementioned framework. Each term was paired with what was considered as its opposite across a 7-point bipolar scale, where 1 represented and 7 "very much" (hot-cold, dry-humid, urban-outdoor, unpleasant-pleasant, uncomfortable-comfortable, sweaty-cool, energetic-calmed, powdery-smooth). Each bipolar scale was anchored with "VERY MUCH," "ENOUGH," and "SOMEWHAT," on each side, as well as a "BALANCED" in the middle.

When it comes to the olfactory notes, participants were asked to indicate how the listened sound evoked eight odor descriptors. Four odors congruently associated with freshness (fresh, floral, fruity, citrus), three associated with a contrasting sensation (spicy, woody, spices), and one that has ambiguous associations with freshness (sweet) were included. Note that, based on the abovementioned literature, these descriptors addressed freshness mainly involving fragrance experiences, and thus they were presented along with some selected odor references (e.g., mint, strawberry, peppers, etc.). The evaluation of each descriptor was based on a 7-point unipolar scale, with 1 being "NOT AT ALL" and 7 "VERY MUCH".

Data analysis

The calculation of the differences between the average values represented the reference for comparison among the sounds, within each category, for every measure. Additionally, a repeated-measures general linear model was conducted using IBM SPSS 26.0 to analyze the differences among the freshness categories (green-fresh, blue-fresh, and non-fresh). Accordingly, no between-participants factors were included, and the freshness category was employed as a within-participants factor. As for the dependent variables, two independent models were executed to observe the sensation and the olfactory scores, separately. Pairwise comparisons were Bonferroni-corrected. In addition, a Principal Component Analysis (PCA) was performed to visually depict the differences among the freshness categories.

Experiment 2

Three hundred and seventy-six participants joined Experiment 2 (gender-balanced sample). Respondents were all over 18 years old (average = 24 years; SD = 5.7). All participants were recruited via https://www.prolific.co/, in which each one was remunerated with approximately US$0.8 for their participation in this experiment.

Materials and stimuli

Eight sounds were used in Experiment 2. Six outstanding sounds from Experiment 1 were chosen as part of the auditory stimuli (four fresh and two contrasting). Three sounds of the GF category (GF1, GF2, GF4) and one of the BF categories (BF3) showed general evidence of triggering the freshest experiences in Experiment 1 (see the Results of Experiment 1). Note that, in Experiment 2, these four sounds are referred to as one single fresh category. In Experiment 1, two sounds of the NF (NF3, NF5) category showed general evidence of triggering the most contrasting experiences to freshness as well.

In addition, to keep the idea of representing a wide variety of rhythms without vocals, two new autonomous sensory meridian response (ASMR) sounds were included in the auditory stimuli. Besides the ASMR feature, these sounds also attempted to comprise the musical features related to freshness described in the Materials and stimuli section of Experiment 1 (see Table B, in the annex, for listening links). Here, each sound lasted between 45 to 60 seconds.

Procedure

Experiment 2's survey was designed on https://www.qualtrics.com to last for approximately 4 min. The procedure of Experiment 2 was the same as in Experiment 1, with the main differences being that each participant had only one stimulus to evaluate (no within-participants comparisons), as well as one additional measure in which the participants were asked to select the color that best matched with the sound that they were listening to (see Measures section for a more detailed explanation).

Measures

In addition to the information detailed in the Measures section of Experiment 1, in Experiment 2, one physical parameter and three lifestyle-experience ones related to brand attributes were added in the bipolar scales section (heavy-light, insecure-courageous, inhibited-free, cautious-explorer). No changes were made in the olfactory notes dimension.

Furthermore, a new dimension was assessed concerning how color matched with the experimental sounds. Here, the participants had to select one of the following colors: yellow, orange, red, purple, blue, and green.

Data analysis

Statistical analyses were performed, using IBM SPSS 26.0. Main effects and interactions were assessed using two independent multivariate ANOVA general linear models (sensations and olfactory notes scores), considering a 95% confidence interval. Each independent ANOVA calculated the effects on sensations scores and olfactory notes, independently, and with sound as a fixed factor. Age and gender were included as covariates. Pairwise comparisons were Bonferroni-corrected. The time that each person took in the experiment was included as a covariate, and correlations with scores were obtained via Pearson's method.

The effects of the sounds on the color choices were estimated by aggregating and comparing the color choices for each sound. In addition, a PCA was performed to visually depict the differences among the freshness categories (fresh and non-fresh) and the new sounds (ASMR).

Results.

Experiment 1

Sensations

In Experiment 1, overall non-fresh sounds (NF) were significantly perceived as more hot, urban, sweaty, dry, energetic, and powdery than the others. Blue-fresh sounds (BF) also significantly triggered those scores (except hot) when compared to green-fresh sounds (GF). GF were also perceived as more pleasant and comfortable than the others.

Table 2 shows the average scores in Experiment 1 for each sensation as a function of each sound within its corresponding freshness category. The overall evidence across this comparison points to GF1, GF2, and GF4, as well as BF3, as evoking the closest scores to the freshness-related attributes. Meanwhile, NF3 and NF5 elicited the closest scores to these opposite-fresh attributes.

Table 2. Average scores in Experiment 1 on sensations. Dark blue background corresponds to the highest scores and dark red corresponds to the lowest ones. Bold rows correspond to what was framed as the outstanding sounds within each freshness category.

	Hot-Cold	Urban-Outdoor	Sweaty-Cool	Dry-Humid	Energetic-Calmed	Un-Pleasant	Un-Comfortable	Powdery-Smooth
GF1	**5,1**	**6,6**	**5,6**	**6,2**	**6,2**	**6,0**	**5,7**	**4,1**
GF2	**4,0**	**5,7**	**5,7**	**4,6**	**6,5**	**6,2**	**6,4**	**5,2**
GF3	4,3	4,7	4,9	4,9	5,6	5,4	5,4	4,4
GF4	**5,2**	**5,7**	**5,8**	**5,3**	**6,2**	**6,5**	**6,4**	**4,7**
GF5	3,9	4,8	5,5	4,1	5,6	6,3	6,0	5,3
BF1	3,8	3,8	4,1	4,3	2,4	3,8	3,4	3,3
BF2	4,2	3,7	4,7	4,3	5,0	5,5	5,7	4,3
BF3	**5,8**	**5,8**	**6,0**	**6,0**	**6,3**	**6,2**	**6,2**	**4,7**
BF4	4,1	4,4	5,3	4,4	5,8	6,2	6,0	4,9
BF5	4,5	3,8	4,6	4,3	4,6	5,5	5,2	4,1
NF1	3,2	2,7	4,8	4,1	4,4	5,9	5,6	4,9
NF2	2,5	2,9	3,3	3,9	2,3	5,0	4,7	3,2
NF3	**2,9**	**2,6**	**3,3**	**3,4**	**2,3**	**5,2**	**4,5**	**3,8**
NF4	2,1	3,3	3,6	3,7	2,6	5,9	5,6	3,5
NF5	**2,5**	**1,7**	**3,5**	**3,9**	**2,5**	**5,3**	**4,8**	**3,3**

The PCA plot depicts a main difference between the BF/GF and NF groups (see Figure 1). The first two principal components explained 61% of the total variance. Most of the scores corresponding to BF and GF tend to be near to the loadings of cold, humid, outdoor, cool, and calmed dimensions. The scores corresponding to NF tend to be on the opposite side instead.

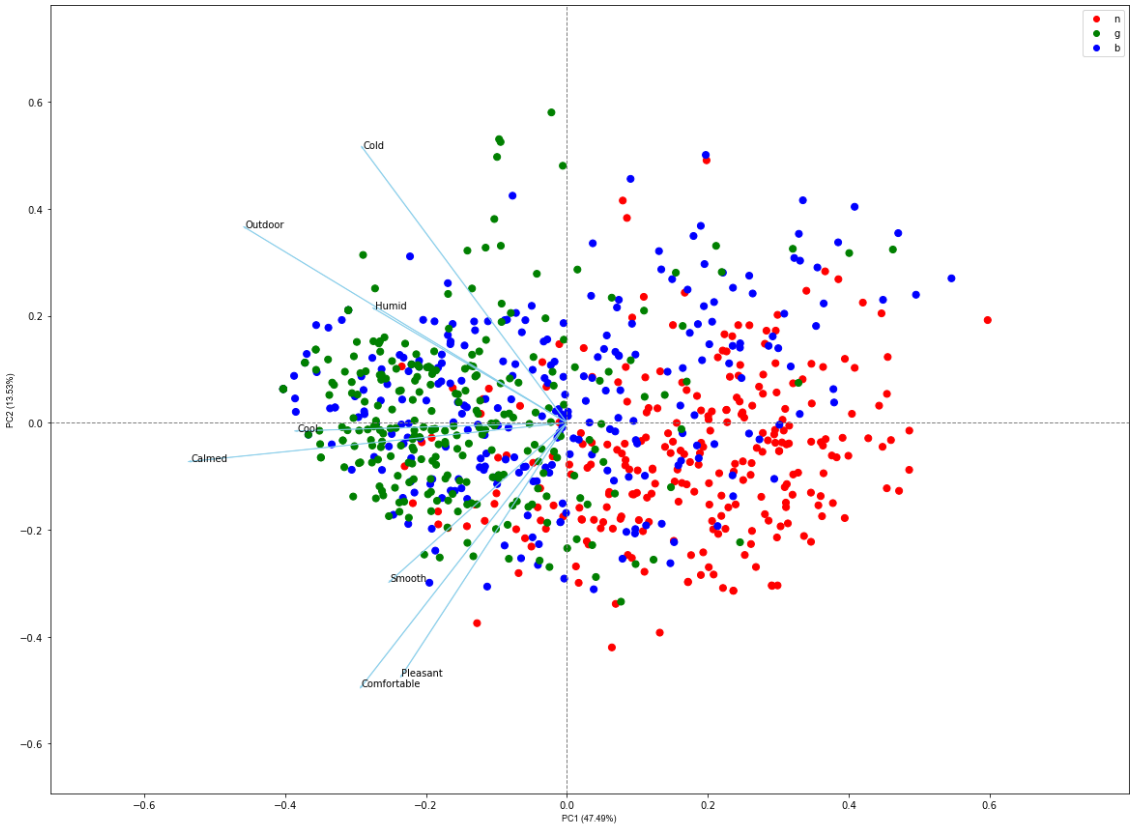

Figure 1. PCA visualization on the scores for the sensation dimensions in Experiment 1. Blue points represent the scores under the blue-fresh sounds. Green points represent the scores under the green-fresh sounds. Red points represent the scores under the non-fresh sounds.

Olfactory notes

Overall NF were significantly perceived as more spicy and less fresh, fruity, floral, and sweet than the others. BF also significantly triggered those scores (except fresh) when compared to GF. GF were also perceived as less citrusy than the others. Note that no effects of freshness category were found for woody and spices scores.

Table 3 shows the average scores in Experiment 1 for each olfactory note as a function of sound within each freshness category. In general, GF1 and GF4, and BF3, are those evoking the closest scores to most of the freshness-related notes (fresh, floral, fruity), as well as the farthest from the spicy note (opposite to freshness). Meanwhile, NF3 and NF5 elicited the closest scores to the spicy note (opposite to freshness) and farthest from most of the freshness-related notes (fresh, floral, fruity).

Table 3. Average scores in Experiment 1 on olfactory note scores. Dark blue background corresponds to highest scores and dark red corresponds to lowest ones. Bold rows correspond to those being framed as the outstanding sounds within each freshness category

	Fresh	Spicy	Fruity	Floral	Citrus	Sweet	Woody	Spices
GF1	**5,1**	**1,5**	**3,9**	**4,8**	**3,2**	**4,0**	**4,2**	**4,2**
GF2	3,9	1,1	4,5	5,1	2,5	5,1	4,1	3,5
GF3	4,3	1,4	3,6	4,5	2,7	3,6	3,2	4,2
GF4	**4,8**	**1,4**	**3,6**	**4,7**	**2,5**	**3,8**	**3,2**	**3,3**
GF5	4,2	1,3	4,5	4,9	3,0	5,1	3,3	3,0
BF1	3,1	2,9	2,9	3,1	4,0	2,9	2,4	3,4
BF2	4,5	2,0	3,9	4,3	3,4	3,6	3,3	3,5
BF3	**4,5**	**1,3**	**3,7**	**4,8**	**2,7**	**4,0**	**4,3**	**3,4**
BF4	3,8	1,9	3,8	4,0	3,1	4,7	3,8	3,8
BF5	4,7	2,2	3,1	3,6	3,3	2,9	3,0	3,6
NF1	4,3	1,6	3,6	3,2	2,9	4,2	3,4	3,2
NF2	3,1	3,7	3,0	3,2	3,7	2,7	2,7	3,5
NF3	**2,4**	**4,4**	**2,5**	**2,7**	**3,2**	**2,5**	**4,2**	**3,6**
NF4	3,2	5,1	2,8	3,5	3,6	3,1	4,8	4,3
NF5	**3,1**	**4,4**	**1,9**	**1,5**	**3,4**	**1,8**	**3,7**	**2,9**

The following PCA plot depicts a main difference between the BF/GF and NF groups (see Figure 2). The first two principal components explained 51% of the total variance. Most of the scores corresponding to GF and some of BF tend to be near to the loadings of fresh, fruity, floral, and sweet notes, while the scores corresponding to NF tend to be on the opposite side and near to the loading of spicy note. Importantly, these scores are more scattered than the sensation ones (compare Figure 1 vs. Figure 2).

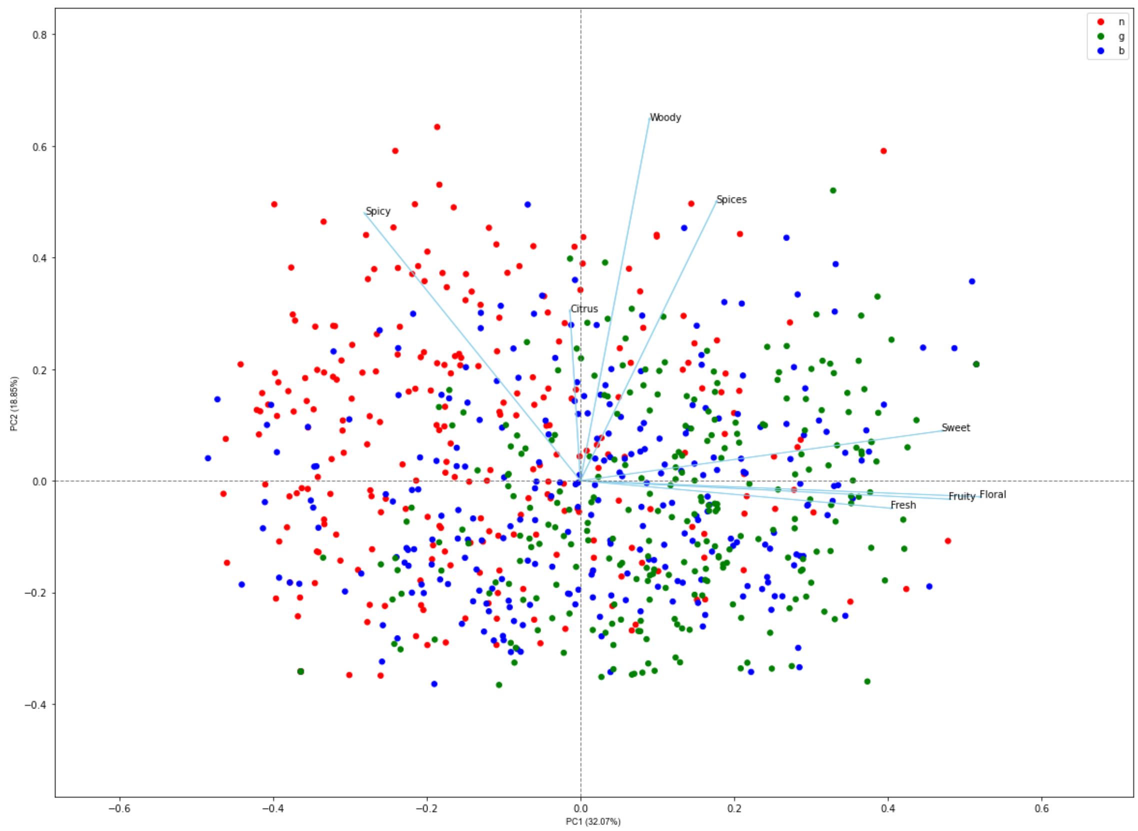

Figure 2. PCA visualization on the scores for the olfactory note dimensions in Experiment 1. Blue points represent the scores under the blue-fresh sounds. Green points represent the scores under the green-fresh sounds. Red points represent the scores under the non-fresh sounds.

Experiment 2

Sensations

In Experiment 2, three of the four fresh sounds (F1, F3, and F4) evoked significantly higher scores on cold, calmed, smooth, and humid sensations than the non-fresh sounds (see also PCA visualization in Figure 3, which depicts such sensation scores). Furthermore, NF2 elicited more contrasting scores on urban, unpleasant, uncomfortable, sweaty, and heavy sensations. The ASMR sounds did not show main differences against the non-fresh sounds beyond cold and calmed sensations. Particularly, F1 was associated more with humid and outdoor sensations than the other fresh ones, while F2 was associated more with cool and light sensations. It is worth noting that inhibited-free, cautious-explorer and insecure-courageous scores did not show main differences between the sounds.

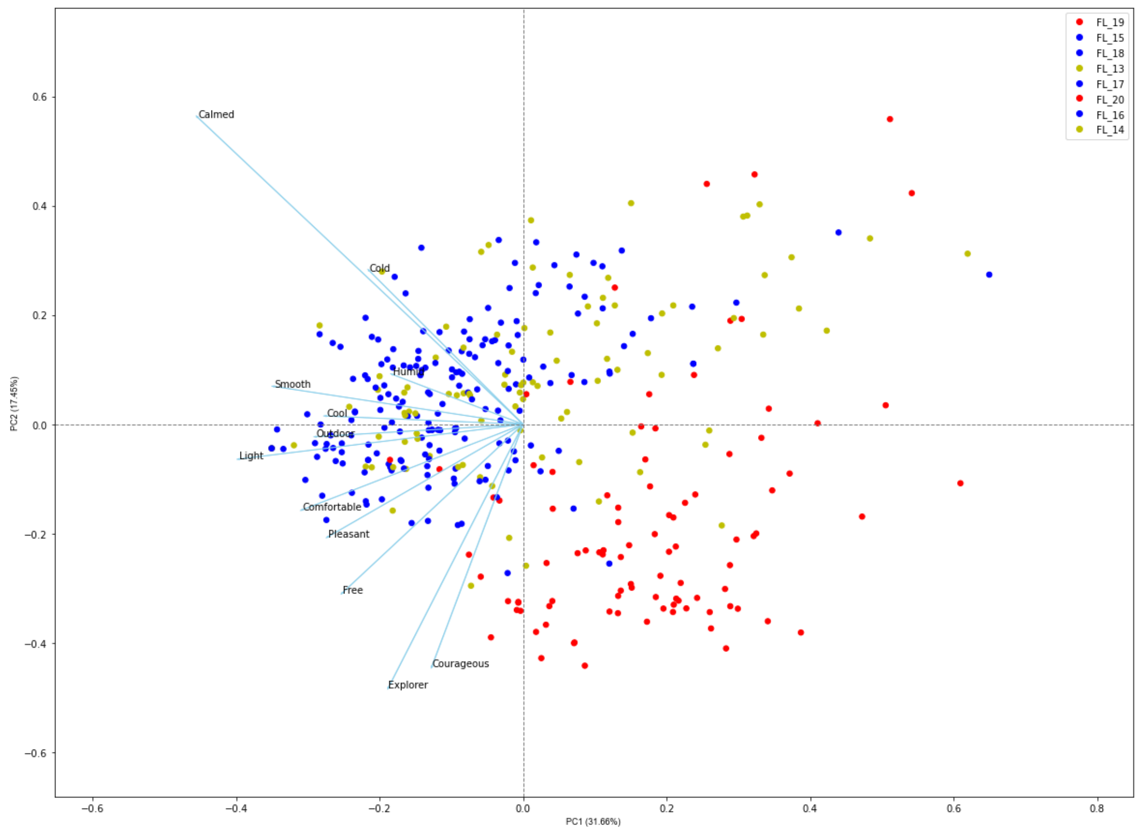

Figure 3. PCA visualization on the scores for the sensation dimensions in Experiment 2. Blue points represent the scores under the fresh sounds. Yellow points represent the scores under the ASMR sounds. Red points represent the scores under the non-fresh sounds.

Olfactory notes

The fresh sounds evoked significantly lower scores on spicy and spices notes than the non-fresh sounds, and three of them (F1, F2, F3) higher scores on fresh note than the non-fresh sounds (see Figure 4 for PCA visualization on olfactory note scores). Furthermore, the sound NF2 elicited more contrasting scores on floral note. The ASMR sounds did not show main differences against the non-fresh sounds beyond the spicy note. Sweet, fruity, citrus, and woody scores did not show on main differences between the sounds.

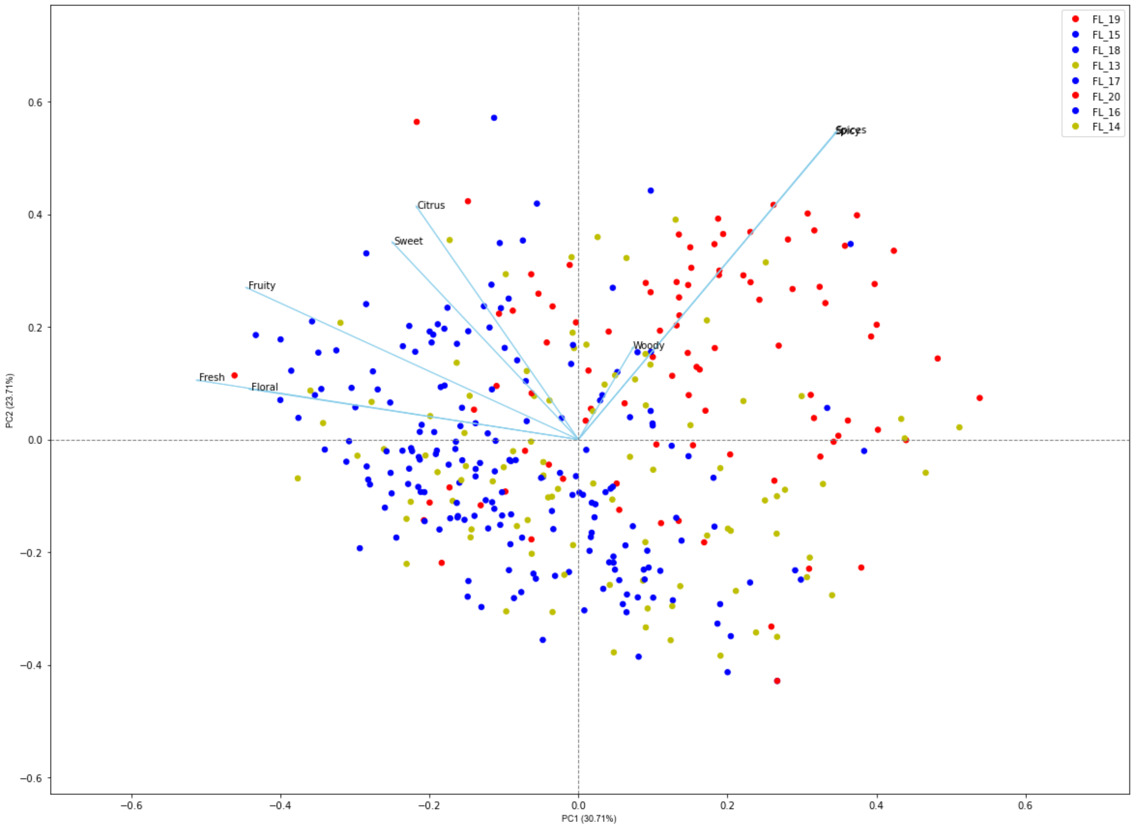

Figure 4. PCA visualization on the scores for the olfactory note dimensions in Experiment 2. Blue points represent the scores under the fresh sounds. Yellow points represent the scores under the ASMR sounds. Red points represent the scores under the non-fresh sounds.

Colors

Table 4 shows that green and blue colors dominated the associations of most participants under three of the fresh sounds (F1, F2, F3). On the other hand, non-fresh sounds were consistently associated with orange or red colors. Noteworthy, ASMR sounds had a dispersed association between orange and blue.

Table 4. Sum of choices that got each color associated to each sound in Experiment 2. In Orange and Red columns, dark red background corresponds to highest number of choices and light red corresponds to lowest number of choices. In the remaining columns, dark blue background corresponds to highest number of choices and light blue corresponds to lowest number of choices.

	Yellow	Orange	Red	Purple	Blue	Green
F1	1	4	0	4	12	26

F2	16	2	1	4	4	20
F3	5	7	0	10	14	11
F4	7	13	1	6	11	9
NF1	3	24	15	1	0	4
NF2	4	9	18	7	3	6
ASMR1	3	10	4	12	11	7
ASMR2	1	12	3	5	13	13

Table 5 shows a comprehensive summary of the highlights of each sound associations with each dimension in Experiment 2.

Table 5. Overall summary of significant differences highlights in the scores for each individual sound in Experiment 2. Hyphens mean that the sound in that dimension did not stand out from the others. In each dimension column, the inclusion of the adjectives account for a greater number of significant differences in scores under the corresponding sound than significant differences for the other sounds.

	Sensations	Olfactory notes	Colors
F1	Humid, Outdoor	Fresh	Green
F2	Light, Pleasant, Comfortable	Less Spicy, Less Spices, Fresh, Fruity, Sweet	Green
F3	Cool, Light, Pleasant, Comfortable	Less Spices, Fresh	Blue
F4	Light, Pleasant, Comfortable	Less Spicy, Less Spices	Orange
NF1	-	-	Orange
NF2	Urban, Sweaty, Heavy, Unpleasant, Uncomfortable	Less Floral	Red
ASMR1	-	-	Purple
ASMR2	-	-	Blue, Green

Discussion.

This study focused on assessing how sounds with specific musical features may be associated with sensations of freshness in the experience of fragrances. We were inspired by the possibility of enabling cosmetics retailing to prompt freshness sensations more effectively in a multisensory experiential context and would illicit similar emotions while smelling the fragrance. Thus, sounds proven to correspond with specific sensations and odor notes of olfactory freshness may be crucial to this purpose.

Overall, the results showed that sensations and olfactory notes associated with freshness were modulated depending on the sound to which the participants were exposed to. Particularly, sounds in which predominated musical features like woodwind and piano instruments, low tempo, and legato articulation (particularly F1, F2, and F3 in Experiment 2) were able to trigger humidity, outdoors, lightness, smoothness, coolness, calmness, freshness, and fruitiness (sensations and olfactory notes associated with freshness), while avoiding the recall for spiciness (opposite to freshness). Note that the same sounds were mainly associated with green and blue colors, which are usually matched with freshness.

In the present study, we validated the effectiveness of certain sounds while triggering freshness sensations, as well as contrasting sensations. These sounds were chosen relying on the existing literature on crossmodal correspondences between semantic, sensory, and emotional parameters associated with the experience of freshness (e.g., temperature, humidity, emotional valence/arousal, olfactory notes) and auditory parameters (e.g., frequency ranges, timbres of musical instruments, musical genre, musical tempo, sounds of nature).

Thus, this study supports a barely studied research path focusing on delivering fragrance experiences using soundscaping. Such correspondence could amplify the customer sensory experience of fragrances and breakdown physical barriers through bringing and connecting the senses of smell and hearing.

Conclusion.

The present study aimed to characterize sounds, in terms of harmony, pitch, dynamics, and genre, that crossmodally correspond with different sensations associated to a particular cosmetic experience (in this case, freshness in fragrances). The framework here proposed was effective in the choice of sounds able to trigger particular sensations and olfactory notes associated with freshness, while avoiding the recall for contrasting ones. These results can motivate cosmetic brands looking for augmenting freshness sensations to consider soundscaping during marketing strategies, bringing people closer to the product, and generating more connection and engagement with consumers.

This novel methodology to design disruptive multisensory experiences with sounds, proven to be congruent with specific sensations may be used to approach to consumers in a different way, while bringing sound experiences in a future new era of fragrance sensations in the consumer journey (i.e., triggering feel-good factors).

We also consider these results as baseline for future work, in which we intend to elicit specific fragrance perceptions and features via sound, and thus enhance customer experience perceptions by means of brand-incorporated sonic logos or in-situ multisensory experiential design techniques, such as sonic seasoning. Accordingly, in-situ experiments aiming to scientifically explore relevance and associations between fresh fragrances and outstanding sounds are likely to happen in the near future.

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Annex

Table A includes the links to each sound employed in Experiment 1 and corresponding codes to refer them in the Materials and Methods and Results sections.

Table A. Sound codes and links of every auditory stimulus employed in Experiment 1 divided by freshness category.

Freshness category	Sound code	Link
Green-fresh	GF1	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_eRP0uAld4a2T2L4
	GF2	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_0cj3XaEJlRaXgZE
	GF3	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_0fuCfMKH7h4LtMq
	GF4	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_a3E4HFw3bexOlw2
	GF5	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_5ihJsIVTKcrSM3s
Blue-fresh	BF1	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_8f8kj3O3DTqhIkm
	BF2	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_0B5ykPUOGsdZ9VY
	BF3	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_7O2QZxSnprUWDXw

	BF4	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_d3VhkmwMnVvBUMK
	BF5	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_8GsEwOM3myL1HMy
Non-fresh	NF1	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_1LdGjqja5v3VigC
	NF2	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_0IoGcMWCDzwmW22
	NF3	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_6gMNUICdmG5OptI
	NF4	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_6nF4iYsYXOQB3qC
	NF5	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_4TnxMSXJod75gb4

Table B includes the links to each sound employed in Experiment 2 and corresponding codes to refer them in the Results sections.

Table B. Sound codes and links of every auditory stimulus employed in Experiment 2 divided by category.

Freshness category	Sound code	Link
Fresh	F1	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_eRP0uAld4a2T2L4
	F2	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_0cj3XaEJlRaXgZE
	F3	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_a3E4HFw3bexOlw2
	F4	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_7O2QZxSnprUWDXw

Non-fresh	NF1	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_6gMNUICdmG5OptI
	NF2	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_4TnxMSXJod75gb4
ASMR	ASMR1	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_dp4BxCC6xRIs9Tw
	ASMR 2	https://psicologiauniandes.eu.qualtrics.com/WRQualtricsControlPanel/File.php?F=F_4HC8lfkYH2GYKSa