Creating your own smellscape

A cross-cultural study between Costa Rica and Japan concerning olfaction and space perception

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Abstract: The current paper's goal is to measure the associations users make between scents and other external cues, according to their own cultural background. Participants from Costa Rica and Japan were asked to smell and rate the contents of 5 different scents in terms of familiarity, preference and pleasantness. After choosing one of the scents they elaborated an artistic collage representing their own associations between the scent and color, shape and composition schemes; all collages were evaluated to determine existing patterns common for both countries. Results show that cultural background and familiarity play an important role in scent perception and evaluation, but is not an essential judgment value when it comes to make associations;   instead, preference levels were more relevant. As expected, major association differences were found in the representative local scents; however, in four out of the five scents, patterns were found amongst both countries: participants formed similar images for the scents in terms of color and spatial attributes regardless of country.

Key words: Space perception, Architecture, Senses, Scents, Artistic collage, Behavior, Smellscape, Olfaction

1. Introduction

Amongst the five senses, the sense of olfaction has been underestimated in terms of Design and Architectural practice; however, the presence of smells can affect directly the user's mood and elicit behavioral changes; turning smells into vital tools that may either improve or deteriorate how users interact with space. This research concerns the role of the sense of olfaction in the way people perceive and behave in their surrounding environments, with the aim of providing better design solutions oriented to improve the whole user experience towards architectural space.   It is divided into two phases, the first one focuses on the possible cultural differences concerning scents, perception and artistic associations; the second one focuses on the application of first phase's results in specific environments to analyze behavioral changes in the presence of olfactory and visual/tactile cues. The current paper is based on the results of the first phase.

2. Background

"Cultural backgrounds impact on how individuals process information about the world. Going back in history, historians and cognitive scientists state that ancient systems of thought still influence contemporary cultural groups. The pivotal example is the difference between Eastern and Western systems of thought, which are characterized by holistic and analytical systems of thought, respectively." [2].

The current research concerns this paradigm difference between Eastern and Western cognition applied to the possible differences between Costarican (West) and Japanese (East) in terms of perceptual approach towards scents. While there are former cross-cultural studies concerning scents perception and color [1] [4], there's few previous research linking scents to physical attributes concerning architectural and space perception. Establishing how users associate scents with other external cues within space can provide specific solutions to improve space quality, through the adequate combination of scents, colors, materials and shapes, for instance.

3. Objectives and hypothesis

The general scope is to analyze whether scent cues combined with spatial elements have an effect in people's perception and behavior within specific environments and therefore increase space quality. Two specific objectives were set:

- Analyze the role of culture in how users react towards scents.
- Establish what kind of associations are made between scents and formal elements

According to those objectives, the following hypothesis was formulated: cultural background has an influence in the way users perceive and rate scents and the way those scents are associated with attributes such as color, shape, composition schemes and spatial attributes.

4. Methodological approach: the *collage* as a perceptual exercise

The term *Collage* refers to an artistic composition made from various materials and pasted on a surface. A collage allows abstract and symbolic representations. Using the collage as an artistic technique encouraged the participants to express by a handmade creation their own impressions about what they smelled. The experiment consisted of rating of scents, the creation of an artistic collage and the self-evaluation of said collage. The participants were given the samples, a questionnaire for scents rating (pre-collage evaluation sheet), materials for collage confection and a second questionnaire for collage self-evaluation (post-collage evaluation sheet). Both questionnaires were composed of evaluation items based on Semantic Differential (SD) scale and free-answer questions.

5. Experiment procedure and generalities

The experiment was held during two main sessions, one in Costa Rica and two in Japan. The participants were 15 from Costa Rica and 11 from Japan, all of them first year students with design and architecture affiliation. Due to the desired subjectivity and freedom in the exercise, a workshop was the selected modality. The participants were encouraged to work as freely as possible and the freedom of technique was highly emphasized.

The name of the workshop, "*Creating your own smellscape*", concerns to the concept of *smellscape* constituted by the contraction of the words *smell* and *landscape* and refers to the idea of an environment composed of a great variety of scents. The other main keyword was the idea of "*own*", which implied the importance of subjective and individual creations during the exercise.

6.1 Tasks

Participants smelled all scent samples, filling the evaluations questionnaire items after smelling each sample. From all evaluated samples they were required to choose one of them, the choosing criteria was free, the only

indication was that they had to choose the scent that caused the strongest emotion / reaction. Based on that chosen scent the next step was the collage creation, they were given color paper in 13 different shades, light modeling wood and working materials and tools (cutters, scissors, and glue). Once they were finished, they were given the second questionnaire for the collage self-evaluation. Both questionnaires were translated to Spanish and Japanese respectively.

6.2 Scents selection and display

The samples consisted of 5 different scents: one representative scent per country, one 'universally' recognizable scent and two generally unfamiliar scents.

6.2.1 Local, universal and unfamiliar scents

For the selection of Japanese and Costarican representative scents, online surveys were performed in both countries. Respondents were 59 from Costa Rica and 41 from Japan. They were shown a list of several scents related to each country and were asked to choose the most representative one. In the case of Costarican scents, *Lizano sauce* was chosen as the most representative one, being a very popular vegetable sauce used on a daily basis in most of households. In the case of Japanese scents, *Igusa* (grass used for tatami mats) was distinguished as the most representative one.

Concerning the universally acknowledged scent, vanilla was selected due to its powerful memories-evoking condition and its positive association. In the case of the two unfamiliar scents, the intention was to select a scent with a "bitter-negative" connotation and the other with a "sweet-positive" connotation; therefore *Tea tree* scent and *Benzoin* were selected respectively (Table 1).

Table 1. Scents selection.

Designation	Scent	Description and properties
A	Igusa	Freshness, relaxation, nature scent, air purifier, moisture absorbance
B	Vanilla	Anxiety reducing, relaxing, pleasant, good memories-evoking, warm, caring
C	Tea tree	Spicy, pungent, antiseptic, stimulant, balsamic
D	Lizano sauce	Spicy but sweet, traditional sauce made from vegetables and spices
E	Benzoin	Relaxing, comforting, soothing, anti-depressant, vanilla-like

6.2.2 Display method

Each scent was distributed in identical polypropylene (PPT) bottles, with no visible contents. For Igusa, dried grass was used; for Lizano sauce, fragrance testing strips of paper were impregnated with the real sauce. For Tea tree and Benzoin scents, essential oils were used to dip fragrance testing strips. Both dried grass and fragrance strips were put inside the bottles and their caps were labeled with alphabet characters from A to E. The participants were divided into three groups and given each group a set of 5 bottled samples.

6.3 Rating criteria

Scents were rated using a SD five point scale in terms of familiarity, preference and pleasure levels. For familiarity: from extremely unfamiliar (-2) to extremely familiar (2). For preference: extremely dislikeable (-2) to extremely likeable (2). For pleasure: extremely unpleasant (-2) to extremely pleasant (2).

6.4 Collage self-evaluation

The participants self-evaluated their own collage, based on the association between it and the chosen scent. For that purpose, they had to rate the level of the following space related attributes in their own collage: width, brightness, height, continuity, weight, fullness, fun, flexibility and warmth; this evaluation was also made through SD scale items, with lowest (-2) and highest (2). This self-evaluation sheet contained two free answer questions as well, the first one inquired the reason for choosing the elements they used (color, shapes, texture, size) and the second one referred to whether the chosen scent reminded them of any particular space and if it did, where and why.

6.5 Evaluation elements

Each collage was decomposed into their components according to three element-categories for their analysis: color, shape and composition scheme. The objective was to measure and establish possible similarities and patterns in the way they associated those elements to the specific scents, according to their cultural background. Color category was defined by the thirteen different shades the participant were given. Shape category was composed by the following: squared, triangular, irregular-organic, irregular-geometrical and circular-curved shapes. Composition scheme category was composed of concentric, orthogonal, linear, scattered and irregular grid schemes. Each element within the three categories was designated with a specific code for reference (Table 2).

Table 2. Element-categories for collages analysis

Category	Element and code						
Color	AZ001	AZ002	AZ003	VR004	CF005	NR006	
	NR007	RJ008	RS009	AM010	NG011	BL012	MD013
Shape	SQ001	TR002	IR003	LR004	CR005		
Composition	CN001	OR002	PR003	SC004	CS005		

7. Results and discussion

The analysis was performed in two main sections, the first one concerning scents rating and perception from a cultural point of view; and the second one referring to the collage and the associations between scents and element-categories (color, shape, composition). The current paper covers the first section and the analysis corresponding to color aspects.

7.1 Semantics

The meaning given to scents was highly relevant in order to evaluate the impact of cultural differences in the way participants perceived and reacted towards the stimuli. The participants were asked to write down what they

thought they smelled, in terms of specific terms or general ideas in case of uncertainty. All answers were analyzed and were reduced to significant keywords per scent (Table 3).

Table 3. Semantic keywords for all scents per country.

Scent / Country	A (Igusa)	B (Vanilla)	C (Tea tree)	D (Lizano sauce)	E (Benzoin)
Costa Rica	Nature	Vanilla products	Clean	Lizano	Bittersweet
Japan	Tatami	Vanilla products	Clean	Food	Bittersweet

Consistent patterns were observed regarding meaning terms for scents B, C and E. Vanilla (B) shows the highest match between the real scent and participants' definition; almost all of them referred to specific products that are popularly flavored or scented with vanilla (e.g. desserts, air fresheners, body lotions, sunscreen and similar). In the case of Tea tree (C) and Benzoin (E), as expected, none of the participants guessed the real scent, but the answers were consistent to the properties attributed to both scents; for Tea tree the general keyword elicited aspects related to cleanness (e.g. cleaning products, cold ointments, hospitals, mint, detergent and similar). Benzoin triggered bittersweet as the general keyword and the used terms are consistent with the "sweet and sour" property of the scent (e.g. medicine syrups, rootbeer, liqueur, candy, incense and similar).

Each country achieved a high level of success in defining its own scent. Concerning their counterpart scent, Costarican participants (which none of them has ever smelled the scent of Igusa) evoked the concept of nature; Japanese participants (also completely unfamiliar to Lizano sauce scent) evoked the concept of food. This result shows that in spite of their cultural background, all participants were able to make similar meaning-association between real and perceived scents and the remarkable differences were noticed only concerning very specific and local scents.

7.2 Scores

All general scores are shown as follows (Table 4):

Table 4. General scores percentage for familiarity, preference and pleasure.

Scent / evaluation item	A (Igusa)	B (Vanilla)	C (Tea tree)	D (Lizano sauce)	E (Benzoin)
Familiarity	0.12	0.73	-0.04	0.42	-0.27
Preference	-0.58	1.12	-0.38	-0.54	0.19
Pleasure	-0.38	0.96	-0.54	-0.85	-0.04

As observed, in general terms vanilla scored highest in all evaluation items, which is consistent with the notion of "universally acknowledged and liked scent". Concerning local scents, Lizano sauce (D) scored relatively higher than its counterpart Igusa (A) which could be attributed to the fact that food related scents are easier to associate with familiar elements; however, preference and pleasure levels scored the lowest between all scents. Overall scores for scents C and E do not show considerable differences. Scores divided by country are shown as follow (Table 5):

Table 5. Scores percentage for familiarity, preference and pleasure per country.

Scent	A (Igusa)	B (Vanilla)	C (Tea tree)	D (Lizano sauce)	E Benzoin)

Country	CR	JP	CR	JP	CR	JP	CR	JP	CR	JP
Familiarity	-1.00	1.64	0.73	0.73	0.07	-0.18	0.73	0.00	-0.53	0.09
Preference	-1.20	0.27	1.60	0.45	-0.33	-0.45	-0.27	-0.91	0.07	0.36
Pleasure	-0.87	0.27	1.40	0.36	-0.33	-0.82	-0.47	-1.36	0.07	-0.18

Results per country show that as expected, highest familiarity scores correspond to both countries rating their own local scent and vanilla as second highest. However, high scores in familiarity levels did not imply that local scents were considered the most preferred or pleasurable. Concerning preference, local scents were rated lower by opposite countries with the exception of Lizano sauce (D) which was rated higher by Japanese rather than by Costa Rica. Concerning pleasure same situation occurs: local scents were rated lower by opposite countries. Tea tree (C) was more familiar for Costarican than for Japanese and opposite situation for Benzoin (E) which scored higher in familiarity for Japanese. Preference levels are relatively high for Benzoin (E) for both countries.

7.3 Collage evaluation

Total number of collages corresponds to 26, 15 from CR and 11 from JP (Table.6).

As previously mentioned, each collage was created based on a single scent chosen by the participant; analyzing the 26 collages in terms of scores of the chosen scent, it was determined that choosing criteria responded more to preference rather than familiarity levels.

Table 6. Total of collages per scent and country.

Scent	Igusa (A)	Vanilla (B)	Tea tree (C)	Lizano (D)	Benzoin (E)
CR	1	7	3	1	3
JP	2	4	2	2	1
Total	3	11	5	3	4

24A (Igusa / JP)   5B (Vanilla / CR)   11C (Tea tree / CR)

18D (Lizano / JP)   9E (Benzoin / CR)

Figure.2 Example of collages

7.3.1 Used elements: color

Color was analyzed in two aspects: the frequency and used color percentage per collage, the frequency established the most used colors associated to all scents and the percentage of color defined the relevance of each color in the collage. Both measures aim to determine if there is any kind of association pattern concerning those specific scents and color. Frequency stands for the number of times a color appeared in the collages per scent. Used color percentage was determined calculating the pixel values for each color in all collages. Combining both criteria, similarities and discrepancies were established amongst both countries and their associations between color and scent.

Average values for frequency and color use: general frequency was similar, out of the thirteen shades; both countries used twelve of them. Overall, Vanilla (B) was the scent with the highest frequency of colors, all thirteen shades were used; Benzoin (E) reported to be the one with the lowest frequency, with seven shades associated to it. This shows that there is a clearer association between colors and Benzoin rather than with Vanilla, which due to its higher familiarity it is easier to associate to a wider variety of colors (Table 7).

Table 7. General percentage values for frequency and color use percentage.

Color use %	AZ001	AZ002	AZ003	VR004	CF005	NR006	NR007	RJ008	RS009	AM010	NG011	BL012	MD013	Freq.
A	4,33	0	18,4	12,8	15	0	0	0	0	7,6	13,1	15,9	12,5	8
B	7,5	4,2	8,1	0,1	5,4	2,8	2,9	0,9	6,8	5,9	18,6	19,4	13,1	13
C	5,3	2,2	25,5	15,6	6,24	0	0	0,9	0	1,9	11,2	18,1	12,3	10
D	0	0	1,6	3,8	24	22,5	0	23	0	1,1	1,67	22	0	9
E	37,3	0	0	9,8	10,6	15	0	14,9	20,7	26,8	0	0	0	7
Average	10,9	1,3	10,7	8,4	12,2	8	0,6	7,9	5,5	8,7	8,9	15,1	7,6	47

Matching and discrepant color values: Taking frequency and use percentage values per country, it was determined which colors and how strongly they were common to both countries per scent. The most significant finding was the lack of common values between Japanese and Costarican for Igusa (A). Its counterpart local scent, Lizano sauce (D) showed a different tendency; the ratio was higher for matching values than for discrepant ones, probably due to the fact that participants could establish a stronger association between food scent and color. For the other scents, the ratio was higher for matching values as well, with no significant differences.

Relevance: After running a Principal Component Analysis (PCA) test for all 26 collages, results show that the most relevant colors for both frequency and use percentage were red (RJ008), orange (NR006), yellow (AM010) and pink (RS009); this shows a consistent pattern for collages based on Benzoin (E) (Table 8 and table 9).

Table 8. Most relevant colors according to PCA results.

Frequency relevance		Use % relevance	
Color	Factor 1	Color	Factor 2
RJ008	0,813	NR006	0,687
AM010	0,729	RJ008	0,687
RS009	0,504	RS009	0,674
		AM010	0,553

Table 9. Collages with highest relevant frequency factors and scents evaluation relation.

Factor 1		Factor 2	
18D	1,626	20B	2,358
9E	1,598	16B	1,437
25B	1,598	1E	1,331
1E	1,454	26E	1,040
19C	1,286	14C	1,009
21D	1,171	9E	0,854
12E	0,879	25B	0,854
26E	0,774	5B	0,712

7.3.2 Associations and patterns

Once established the color patterns, the values for the collages self-evaluation based on space related characteristics were analyzed. Those characteristics were defined within two groups, *physical*: width, brightness, height, weight; and *emotional*: continuity, fullness, fun, flexibility and warmth. In general terms, five out of the nine characteristics show Benzoin (E) as the highest rated. The lowest scores are distributed more evenly between scents A, C, D and E. According to PCA results, the most relevant attributes amongst the 26 collages were distributed in two main factor groups (Table.10): the first one includes flexible, full and bright; and the second one: light and low. Almost all collages based on Benzoin (E) show a high content of both groups' characteristics.

Table 10. Most relevant space attributes in the totality of collages, according to PCA results.

Attribute	Factor 1	Attribute	Factor 2
Flexible	0,793	Light	
Full	0,729	Low	
Bright	0,604		

For those relevant attributes, the following collages are the ones with the highest presence of factors:

Table 11. Collages with the highest presence of spatial attributes.

Factor 1		Factor 2	
17B	1.862	13B	1.89
9E	1.263	20B	1.642
25B	1.208	12E	1.147
12E	0.89	24A	0.963
20B	0.875	5B	0.957
11C	0.797	3C	0.832
3C	0.636	9E	0.593
26E	0.618	26E	0.536
1E	0.528	16B	0.492

7.3.4 Conclusions

Similar patterns were found between both countries in terms of evaluating and defining scents. As expected, local scents report the most appreciable differences in both scores and meaning attribution: both countries had the tendency of rating higher their own scents. Concerning the semantic approach, clear local patterns were defined between same country participants towards their counterpart local scent; even if the scent was totally unfamiliar, the keywords used to describe it were grouped under the same category, no discrepancies were found. At this point it can be established that familiarity plays a key role on defining and evaluating scents: the higher the familiarity the more accurate descriptive words were used. The observed nuance is the high subjectivity of scents and olfaction, familiarity was succinct to what participants *thought* they smelled.

However, concerning associations between scents and color / spatial attributes, cultural familiarity was not relevant; instead preference level played a more significant role when choosing scents and relating them to other elements. It was more important *how they liked* the scent rather than *how well they knew it*. Color was used in a similar way in both countries and, as expected again, the remarkable differences were observed in terms of local scents: no color pattern could be recognized for Igusa (A) between both countries, color representation was completely different. In the case of Lizano sauce (D) a color pattern could be established (CF005, brown was a common value), but the general representation was slightly different between both countries: CR participants emphasized the use of green due to the real association of the sauce to vegetables; while JP participants used *spicier* shades (red, orange, yellow) because of its association to spicy food in general.

The remaining scents did not report significant differences, colors were used similarly: as expected due to the characteristics of each scent, cooler shades were selected for Tea tree (C) and warmer shades for Benzoin (E). The case of vanilla is very interesting in both countries because of the multi-color association it was made due to the high familiarity level. Between all scents, Benzoin (E) reported the highest similarity rate and Igusa the lowest.

In terms of spatiality similar patterns and discrepancies were established, again the most remarkable differences were found in local scents. Benzoin (E) was also the scent reporting most similarities between scents. In general terms, height and continuity were the properties with the least relevance for both countries. Finally a synthesis was made according to the found patterns and discrepancies (Table.12):

Table 12. Final association patterns between scents, color and space.

Scent	CR		JP		Common
	Color	Attribute	Color	Attribute	
A	Yellow, wood, black	Narrow, dense, not flexible, not so bright	Blue, green, brown, white	Wide, light, cold	-----------
B	Blue shades, brown, wood	Warm	Black, green, orange, red	Wide, low, continuous	Yellow, white, very bright, fun and flexible
C	Green, black, wood	Wide, bright, dense, flexible	Brown, red, yellow	Narrow, light	Blue, white, fun and cold
D	White, green	Tall, warm	Orange, red, yellow	Full, flexible	Brown, narrow and fun
E	Red, green	Continuous	Brown	Light	Blue, pink, yellow, wide, bright, full, flexible and warm

As far as this experiment comprises, the following conclusions can be drawn. In spite the high level of subjectivity concerning scents and olfaction, personal preferences (including personality traits, specific memories and similar) and cultural background, general tendencies and patterns were established per each of the five scents. Considering this and the previous result concerning semantics and evaluation, it can be said that the initial hypothesis was partially met: cultural background and familiarity do play an important role in scent perception and evaluation, but is not an essential criteria when it comes to make associations between the scents and color / spatial cues.

8. Further activities

According to the current results, the strongest patterns were established for Benzoin (E). Taking this into account, the same analysis will be performed with shape and composition schemes so the resulting patterns, in combination with color cues will be used to create new stimuli to be tested in a real scale environment in order to determine if said combinations (scent, color, shape, composition) could propitiate behavioral changes in the user within space.

9. References

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10. Acknowledgments