

# Color Culture and Science Cultura e Scienza del Colore

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Editors: Verena M. Schindler, Yulia A. Gribner



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# An educational experience about color emotion and its design implications

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## ABSTRACT

The paper presents the context, contents and results of an educational experience conducted within the Shapes, Surfaces and Colours module of the Master in Furniture Design by Poli.Design, Politecnico di Milano, in December 2018. This experience is part of a color design education research project with the aim to explore, evaluate, experiment and systematize design implications offered by the evaluation of the emotional response to color in design education and professional practice.

Besides the educational purposes, this experience allowed us to verify, evaluate and compare the presence of associative recurrences between a selection of emotion words and color attributes, firstly with an initial exploration without using color samples, and secondly with the construction of contextualized 4-color combinations. Finally, in a process of student-learning and experimentation that moves from abstraction and generalization towards design contextualization, the possibility of using such experiences and connotative associations to build the emotional character of an interior space was explored.

The results of this experience contribute to validating the design opportunities offered by the possibility of dealing with the evaluation of the emotional response to color in terms of color attributes, and thus of color combinations. In addition, the use of such associative assumptions to build the emotional character of an interior space seemed to be a useful educational and methodological tool to relate color to the other design components—shape, material and surface, in particular—and to show the potential value of a design process structured around color and the sensorial and emotional qualities of the environment.

**KEYWORDS** Color Design Education, Color Emotion, Color Association, Color Combination

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## 1. Introduction

The evaluation of the emotional response to color, or 'color emotion', concerns both the aesthetic experience of color and the connotative experience of color in relation to concepts such as warm or cool, light or dark, heavy or light (Sivik 1970, Gao and Xin 2006). As Lars Sivik (1970:43, 1989:132) points out, the prerequisite for this type of studies lays in the fact that people prove to be sufficiently concordant in their connotative experiences and opinions about color.

As Ou et al. (2004a:232) observe, early studies on single-color emotion were concerned with the possibilities of reducing a large number of color-emotion scales into a smaller number of categories, or *factors*, by using the semantic differential method introduced by Osgood et al. (1957). These studies also revealed connections between these *factors* and the three color attributes, generally defined as hue, brightness or lightness for object colors, and chroma or saturation (Wright 1962) [1].

As noted by Küller (1981:162) regarding this area of research and compared to the numerous studies conducted on single-color-without-context, only few studies were concerned with color combinations.

Among the studies focused on the implications of using not just single colors but combinations of two or more colors, Sivik and Hård (1989) investigated how different dimensions of meaning can show varying degrees of relationships with different kinds of 4-color combinations. Kobayashi (1991) proposed a systematic classification of color combinations using 130 basic colors to create different 3-color combinations and 180 matching image words. Ou et al. (2004a, 2004b) conducted a study on both single colors and 2-color combinations in relation to those color-emotion scales that were most used in previous studies.

Within this framework, the educational experience carried out within the Shapes, Surfaces and Colours module of the Master in Furniture Design by Poli.Design, Politecnico di Milano, enabled students to experiment and evaluate the design implications related to the emotional response to color in terms of 4-color combinations, and provided the possibility of using such experiences and connotative associations to conceptualize the emotional character of an interior space.

This experience is part of a color design education research project with the aim to explore, evaluate, experiment and systematize the design implications offered by the evaluation of the emotional response to color in design education and professional practice. The research project is focused on the possible relationships between the approaches, methods and outcomes of color

research that deals with color emotion and the approaches, methods and tools developed in the field of design research and practice that deals with color and the emotional and sensorial qualities. In this regard, note the methods and tools developed in the field of CMF design (colors, materials, finishes) and Qualistic by Clino Trini Castelli (Castelli 1995, 1999) and the Color Image Scale by Shigenobu Kobayashi (Kobayashi 1991). The research outcomes may highlight aspects of development in the area of color research oriented to possible design applications in terms of the contextualization and usability of the research results.

The educational experience presented here follows the results of a previous didactic experimentation (Boeri 2019) that allowed exploring and evaluating the possibility of establishing associative recurrences between a selection of 'evocative terms' and 4-color combinations developed by the students drawing from an almost unlimited number of color samples.

Numerous studies on single color emotion (Ou et al. 2004a, Gao and Xin 2006, Da Pos and Valenti 2007), color pairs (Ou et al. 2004b) or 4-color combinations (Sivik and Hård 1989) are based on a predefined number of color samples.

In the experimentation presented in this paper students were first asked to establish associations between a selection of connotative terms, in the form of pairs of opposites, and color attributes in absence of color samples, and then to establish associations between one or two of the connotative terms selected and 4-color combinations drawing from the 1,950 standard colors of the NCS system, which leads to an even higher number of color combination possibilities (Sivik and Hård 1989).

In a process of learning and experimentation that moves from abstraction and generalization towards design contextualization, the possibility of using such experiences and connotative associations to build the emotional character of an interior space was explored.

This contribution presents the contents and methods of this teaching experience and the student-learning results in order to evaluate the associative recurrences and relevancies between the selected terms and the color attributes.

## 2. Contents and method

The teaching experience planned within the Shapes, Surfaces and Colours module of the 1st level Specializing Master in Furniture Design, Learning from the Italian experience, by Poli.Design, Politecnico di Milano, was conducted by the author in December 2018, over a period

of 3 days and covering a total of 21 hours. The color course was organized to offer students theoretical contents on color and practical color design implications. Following a teaching method that had already previously been partially tested (Boeri 2019), twenty-four students from different nationalities were asked to proceed in two phases. The first phase was configured to allow students to explore and experiment with the design implications of the 4-color combinations associated with a selection of connotative terms, or 'color emotion words' (Nakamura et al. 2005), chosen on the basis of their recurrence in the literature addressing the emotional response to color, or color emotion, (Ou et al. 2004a:233), and their relevance to possible design developments [2]. The terms selected in the form of pairs of opposites were: *classic-modern*, *cool-warm*, *dynamic-quiet*, *hard-soft*, and *heavy-light*. The second phase was conceived to experiment and evaluate the possibility of applying the associations and 4-

color combinations previously developed to build the emotional character of an interior space.

The two phases were developed following a process of student-learning and exploration that moves from a rather abstract and general content towards a specific contextualization in a student's design project (Fig. 1).

In summary, the students were first asked to place each of the proposed emotion words within an organized map with a vertical axis of lightness and a horizontal axis of saturation forming four quadrants. Each axis is further subdivided into 10 equal steps, with 0 at the intersection of the axes and increasing to 10 at the periphery. Additionally, the two quadrants to the left are characterized by the association *cool* and the two quadrants to the right with the association *warm*. The association with cool and warm is taken as an indicator of an evaluation concerning also the hue attribute (Fig. 2).

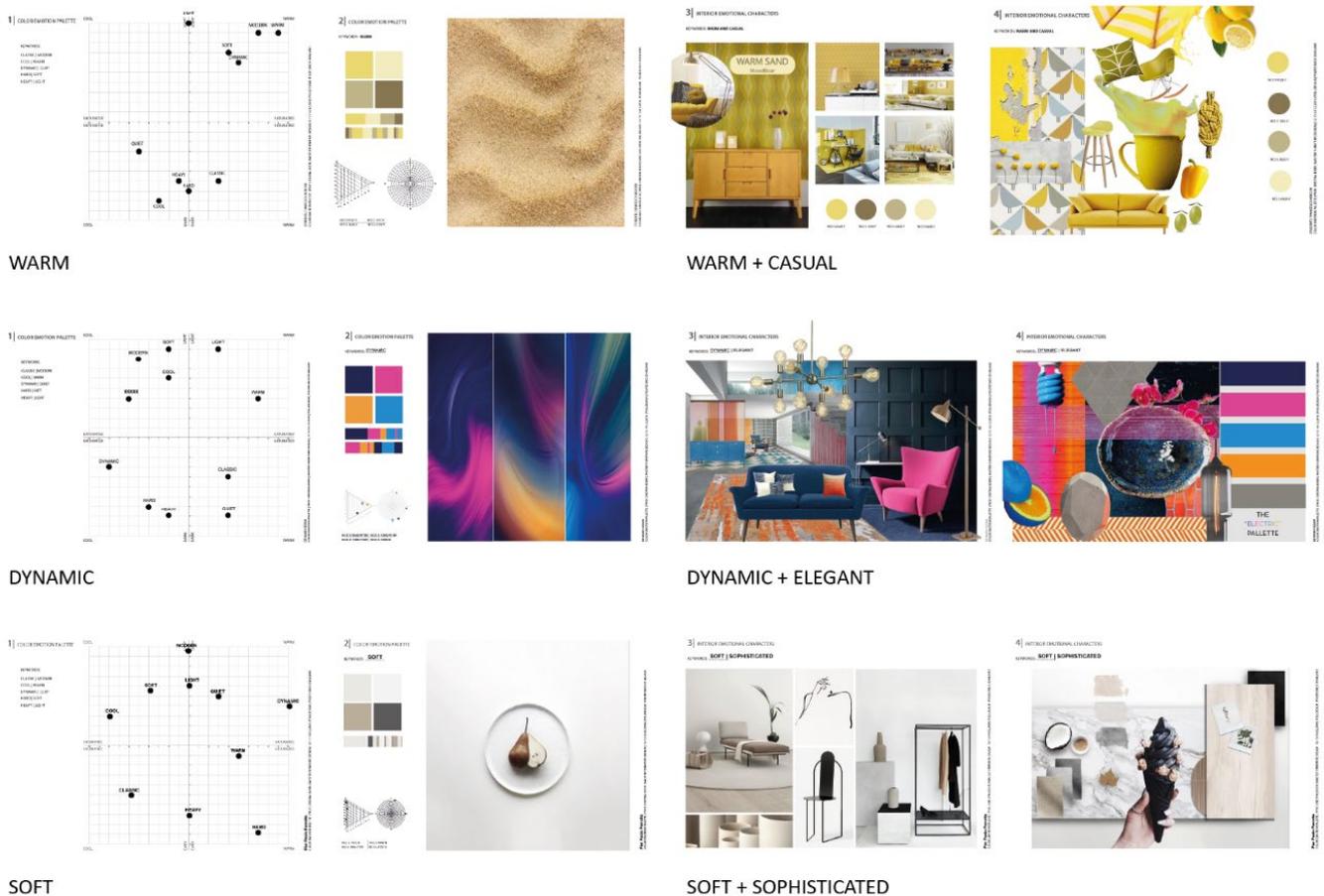


Fig. 1. On the horizontal rows are shown three students' work, produced in the course's 1st phase (two plates left) and 2nd phase (two plates right) of the Shapes, Surfaces and Colours module (Professor: C. Boeri) of the Master in Furniture Design, Poli.Design, Politecnico di Milano (Director of the Master's course: A. Deserti; Co-Director: F. Zurlo). Students: Francesco Mercuri, Devanshi Doshi, Pier Paolo Perrotta.

The visual organization and the terminology represented in the map of color attributes is designed to help students complete the required task. It takes into consideration that this may be the students' first exposure to color attributes and associations. The map and the emotion words were explained to the students in advance. This task had a dual purpose: on the one hand, to invite students to explore all the proposed words before proceeding to the choice of the ones they wanted to develop; and, on the other hand, to evaluate the possibilities of establishing associations between emotion words and color attributes in the absence of color samples.

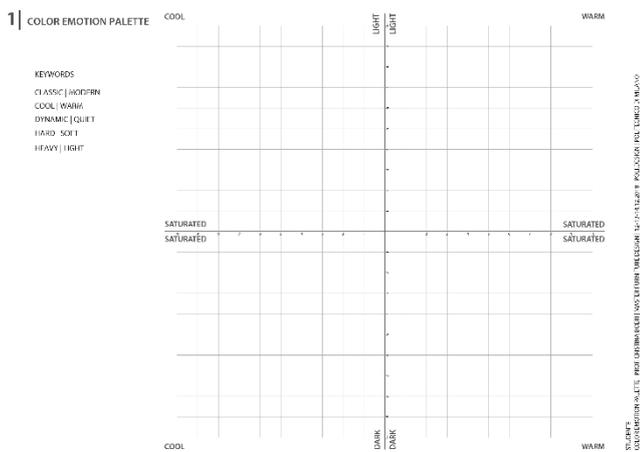


Fig. 2. The map provided to the students to explore and evaluate the associations that can be established between the selected word pairs and the color attributes. At the intersection of the axes there is a medium gray (= 0), at the ends of the axes the maximum lightness, darkness or saturation (= 10).

Subsequently, the students were asked to freely choose one or two emotion words from those proposed and then build 4-color palettes associated with each word using the visual selection from the NCS 1,950 standard color samples and the NCS Navigator. The pre-set plate supplied to the students envisaged that for each palette there would also be some evocative images useful to contextualize the palette in relation to the sought after association, the visual hierarchies that each color can take inside the palette and the characteristics of each color and color combination with respect to the color attributes using the NCS color circle and NCS triangle (Fig. 3 a, b).



Fig. 3 a, b. Two examples of students' 4-color palettes associated with the word 'cool'. Students: Natalia Arkharova, Firas Abu Dahab.

In a second phase the students were asked to apply the associations they found between the emotion words and the palettes previously developed to build the emotional character of an interior space. In summary, the students were asked to develop two mood-boards able to describe and synthesize through images the emotional and sensory characteristics of an interior space, referring to the domestic or retail environment, using as main reference the emotion word and the relative color palette already developed, and declined according to a further connotation to choose from within a new selection of the proposed word pairs: *casual–elegant*, *playful–serious*, *simple–sophisticated*. Divided into two plates, the task initially involved the construction of a mood-board aimed at creating a strongly evocative 'character' of an interior environment related to the selected emotion words, and subsequently at conceiving an inspirational material-chromatic scenario (Fig. 1, two plates right).

The students' works were analysed in part during the course to provide a basis for verification, comparison and

shared discussion with respect to the results produced, and in part in retrospect, to verify, evaluate and compare the presence of associative recurrences between emotion words and color attributes both with respect to the initial exploration, without color samples, and to the colors and organisational schemes used for the construction of the 4-color combinations.

### 3. Results and discussion

The initial map results, in relation to a total number of 17 works submitted, were visually rearranged to show the presence of possible associative recurrences in relation to the lightness and saturation attributes and the cool–warm polarity, for each emotion word (Fig. 4).

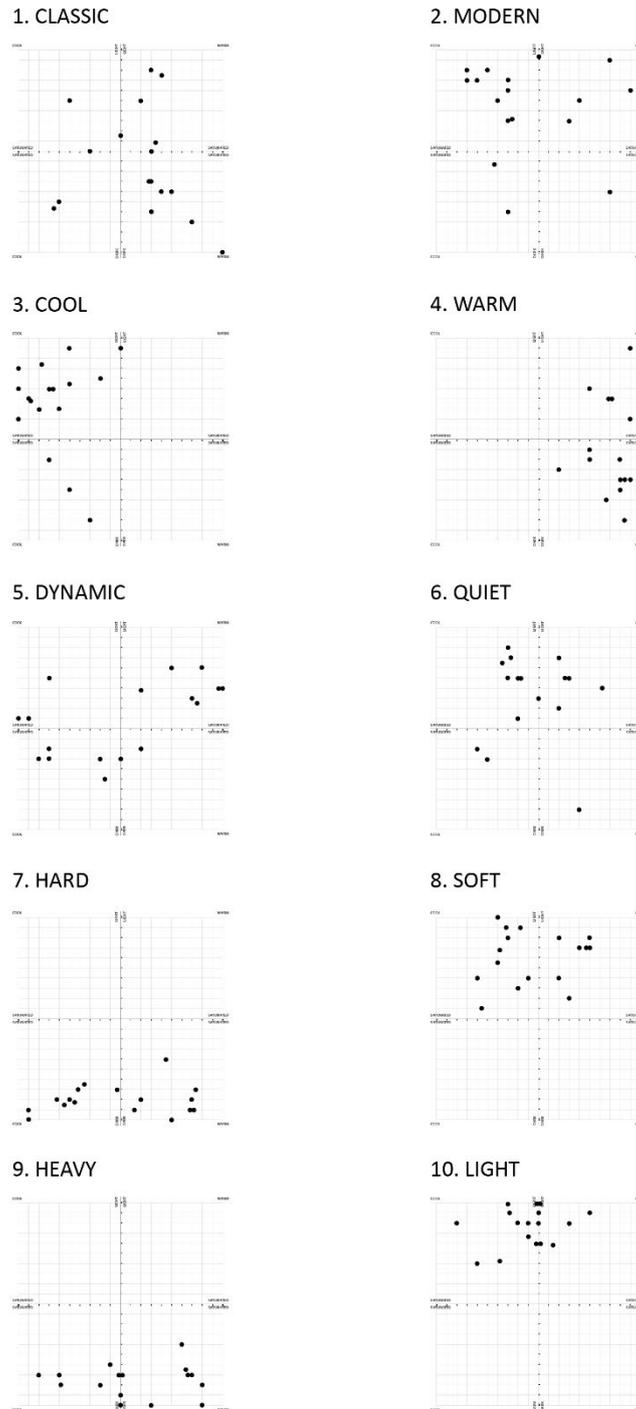


Fig. 4. The maps with the results from 17 works submitted were visually rearranged to show the presence of possible recurrences in relation to the attributes of lightness and saturation and to the cool and warm connotations for each word. One submission was incomplete in that it did not include 'quiet' and 'heavy'.

The results show for the *classic-modern* polarity a concentration of associative evaluations in relation to the cool-warm polarity, with (1) *classic* that presents a greater concentration of evaluations in the quadrants connoted with warm (Fig 2, right half of the map) and (2) *modern* in those connoted with cool (Fig. 2, left half of the map), and, for *modern* also appears a concentration of evaluations in relation to the quadrants connoted with light (Fig. 2, upper half of the map ranging from 0 = medium gray to 10 = maximum lightness). The *cool-warm* polarity (in addition to the obvious correspondence with the cool and warm halves) shows on the map a concentration of associative evaluations related to the lightness attribute with (3) *cool* that presents a greater concentration of evaluations in the quadrant connoted with light and cool and (4) *warm* in the quadrant connoted with dark and warm. The *dynamic-quiet* polarity shows a concentration of associative evaluations in relation mainly to the saturation attribute, with (5) *dynamic* that presents a greater concentration of evaluations in the saturated areas (5-10) and (6) *quiet* that presents an even more evident concentration of evaluations in the desaturated areas (0-5). The *hard-soft* and *heavy-light* polarities show a concentration of associative evaluations mainly in relation to the lightness attribute, with (8) *soft* and (10) *light* that present greater concentrations of evaluations in the quadrants connoted with light, and (7) *hard* and (9) *heavy* in those connoted with dark (Fig. 2, lower half of the map ranging from 0 = medium gray to 10 = maximum darkness). In addition, (10) *light* presents a greater concentration of evaluations on the vertical gray axis and in the lightness areas (6-10) and is related to the cool connotation compared to (8) *soft* that presents a greater distribution on the upper half of the map.

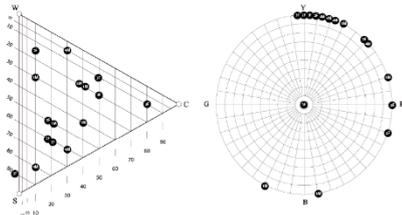
The results of the analysis of the colors and organisational schemes used for the construction of the 4-color palettes, carried out in retrospect on a total number of 37 works, were visually synthesized using the NCS triangle and NCS circle to show the presence of possible recurrences and their relevance in terms of hue and/or nuance (Fig. 5).

Taking into account the number of works that could be analysed for emotion words, the most relevant results show: for (1) *classic* a recurrence of color combination schemes based on hue analogies and a concentration of the mostly used hues in an area of the circle between Y and R20B; for (3) *cool* a recurrence of color combination schemes based on hue analogies and a concentration of the mostly used hues in an area of the circle between R90B and B20G; for (5) *dynamic* a recurrence of color combination schemes based on the differentiation of hues (at least 2 hues) and a concentration of the mostly used hues in three areas of the circle, between Y and Y30R, between Y90R and R10B, and between R70B and B; for

(6) *quiet* a recurrence of color combination schemes based on nuance analogies and a concentration of the mostly used nuances in an area of the triangle with blackness between 05 and 20 and chromaticness between 0 and 30; for (8) *soft* a recurrence of color combination schemes based on nuance analogies and also on hue analogies with at least two hues identical or closely located on the circle, and a concentration of the mostly used nuances in an area of the triangle with blackness between 05 and 30 and chromaticness between 0 and 30; for (9) *heavy* a recurrence of color combination schemes based on nuance analogies and a concentration of the mostly used nuances in an area of the triangle with blackness between 40 and 90 and chromaticness between 0 and 40; for (10) *light* a recurrence of color combination schemes based on nuance analogies and hue analogies and a concentration of the used nuances in an area of the triangle with blackness between 05 and 30 and chromaticness between 0 and 30; for (2) *modern* any recurrence in the color combination schemes appears; for (4) *warm* and (7) *hard* the colors and organizational schemes that can be analyzed refer to single works; and, for (4) *warm* a color combination scheme based on the same hue Y and for (7) *hard* a color combination scheme based on the analogy of 3 nuances characterized by blackness between 60 and 90.

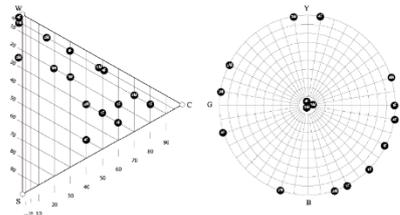
The comparison of the results of the analysis of the colors and organisational schemes used for the construction of the 4-color palettes (Fig. 3 a, b) with the results of the initial exploration inserted on the maps (Fig. 4) allows us to observe and evaluate the presence of possible coherences with the associative evaluations emerged between emotion words and color attributes. In particular, the development of the 4-color palettes associated with the *classic-modern* polarity shows a coherence with the associative evaluation mainly in connection to cool and warm limited to the emotion word (1) *classic* and with reference to the hue attribute with a concentration of the mostly used hues in one area of the circle, between Y and R20B that correspond to the so-called 'warm hues' (Wright 1962, Da Pos and Valenti 2007). As well, the development of the 4-color palettes associated with the emotion word (3) *cool* shows an associative evaluation in connection to the hue attribute with a concentration of the mostly used hues in an area of the circle, between R90B and B20G that correspond to the so-called 'cold hues' (Wright 1962, Da Pos and Valenti 2007). The development of the 4-color palettes associated with the *dynamic-quiet* polarity shows a coherence with the associative evaluation mainly in connection to the saturation attribute especially for the emotion word (6) *quiet*. The development of the 4-color palettes associated with the *hard-soft* and *heavy-light* polarities show coherences with the associative evaluations mainly in connection to the lightness attribute.

1. CLASSIC



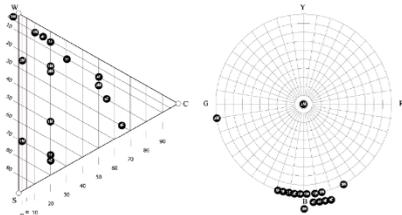
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2. MODERN



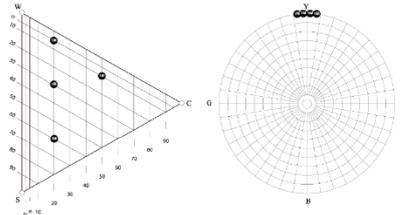
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3. COOL



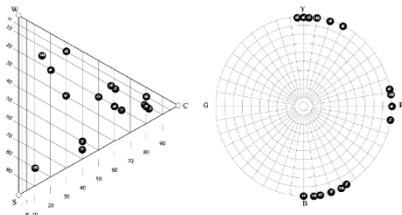
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4. WARM



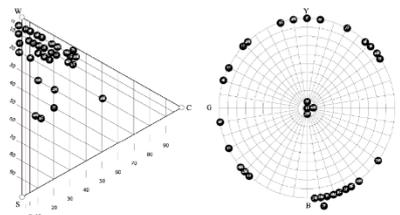
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5. DYNAMIC



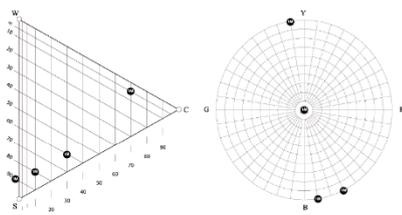
Total works: 4

6. QUIET



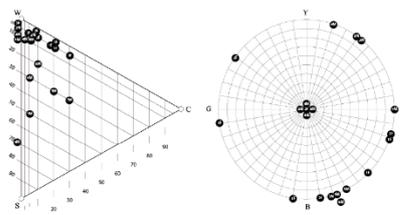
Total works: 8

7. HARD



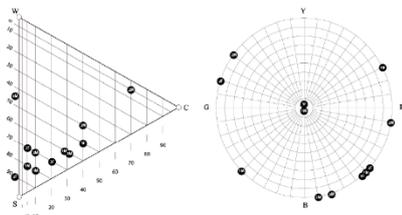
Total works: 1

8. SOFT



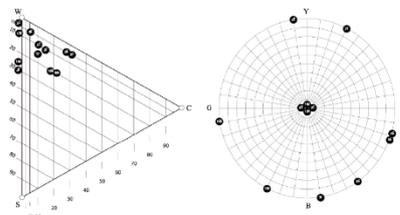
Total works: 5

9. HEAVY



Total works: 3

10. LIGHT



Total works: 3

Fig. 5. The results of the analysis of the colors and the patterns used for the construction of the 4-color combinations associated with the selected emotion words, conducted on a total number of 37 works, were visually synthesized using the NCS triangle and NCS circle. The 4-color combinations associated with each emotion word can be identified by the letter F = female or M = male and a progressive number (visible enlarging the image).

Compared to previous studies, these results seem to confirm for the *hard–soft* and *heavy–light* polarities the connection to the lightness attribute (Ou et al. 2004a, Gao and Xin 2006). While for the *cool–warm* polarity the results of the palette developments seem to confirm the connection to the hue attribute (Wright 1962) but not the connection with both hue and chroma (Ou et al. 2004a, Da Pos and Valenti 2007) or with chroma only (Gao and Xin 2006). In addition, the connection to the lightness attribute that emerged from the initial exploration with the map, does not appear relevant in previous studies (Da Pos and Valenti 2007).

These results lead to some considerations with respect to the method adopted concerning the possibility of establishing associations between the selected connotative terms or emotion words and the color attributes both in absence of color samples and in presence of a high number of color samples and an even higher number of color combination possibilities (Sivik and Hård 1989). This way of proceeding, according to the students' design training, contribute to validating the design opportunities offered by the possibility of dealing with the evaluation of the emotional response to color in terms of color combinations.

The considerations on the outcomes of the second phase, related to the contextualization of the emotion words and their related 4-color palettes, are limited to a didactic evaluation of the experimented design process. Design students are generally used to work with the possibilities of establishing associations between concepts, key words and visual syntheses. In the design process proposed in this experience the use of the evaluation of the emotional response to color allowed students to explore and evaluate a systematic approach to these associative experiences, starting from color in order to define the sensorial and emotional qualities of the environment.

#### 4. Conclusions

The results of this educational experience and experimentation contribute to validating the design opportunities offered by the possibility of dealing with the evaluation of the emotional response to color in terms of color attributes, and thus of color combinations. In addition, the use of such associative assumptions to build the emotional character of an interior space seemed to be a useful educational and methodological tool to relate color to the other design components, in particular shape, material and surfaces, and to show the potential value of a design process structured around color and the evaluation of the emotional qualities of the environment.

#### 5. Conflict of interest declaration

The author declares no conflict of interest related to this publication.

#### 6. Funding source declaration

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#### 7. Short biography of the author

**Cristina Boeri** is an Architect PhD, her activity in the research, teaching and professional sectors, deals with aspects related to the color perception and design. Since 2001, she carries out educational and research activities in the Color Lab of the Department of Design of the Politecnico di Milano. She is adjunct professor of Color and Perception at the School of Design, Politecnico di Milano.

#### Notes

[1] For color attribute definitions see Kuehni, R. G. (2003). *Color Space and Its Divisions. Color Order from Antiquity to the Present*. Hoboken: Wiley and Sons. In this paper, the terms used to define the color attributes in the respective studies reported have been kept.

[2] Compared to the ten bipolar color-emotion scales used in the experiment of Ou et al. (2004a:233) as the most frequently used in early studies (*warm-cool*, *heavy-light*, *modern-classical*, *clean-dirty*, *active-passive*, *hard-soft*, *tense-relaxed*, *fresh-stale*, *masculine-feminine*, and *like-dislike*), the opposites *warm-cool*, *heavy-light*, *hard-soft* were selected; *modern-classic* was preferred to *modern-classical*; *dynamic-quiet* was preferred to *active-passive*.

#### References

- Boeri, C. (2019) 'An educational experience on the exploration and experimentation of colour associations and relationships', *Journal of the International Colour Association*, 24, pp. 1–10.
- Castelli Trini, C. (1995) 'States of domesticity', *The Dream of Power: Reality and Utopia in Home Automation*, Casciani, S. (ed.) *The new living and light series from BTicino and CMF project from Clino T. Castelli*. Milano: Città Studi edizioni, pp. 69–79.
- Castelli Trini, C. (1999). *Transitive design*. Milano: Electa.
- Da Pos, O. and Valenti, V. (2007) 'Warm and cold colours' AIC 2007 *Color Science for Industry, Proceedings of the Midterm Meeting of the International Color Association*, Guanrong, Y. and Haisong, X. (eds.) Hangzhou: Color Association of China, pp. 41–44.
- Gao, X-P. and Xin, J. H. (2006) 'Investigation of human's emotional responses on colors', *Color Research and Application*, 3(5), pp. 411–417.
- Kobayashi, S. (1991) *Color Image Scale*. Tokyo: Kodansha International.

Kuehni, R. G. (2003) *Color space and its divisions: color order from antiquity to the present*. Hoboken: Wiley and Sons.

Küller R. (1981) *Non-Visual effects of light and colour*. Annotated Bibliography. Stockholm: The Swedish Council for Building Research.

Nakamura, T., Sakolnakorn, P. N., Hansuebsai, A., Pungrassamee, P. and Sato, T. (2005) 'Emotion induced from colour and its language expression' AIC 2004 Color and Paints, Proceedings of the Interim Meeting of the International Color Association, Caivano J. L. and Struck H.-P. (eds.) Porto Alegre: Associação Brasileira da Cor, pp. 328–331.

Osgood E. C., Suci G. J. and Tannenbaum P. H. (1957) *The measurement of meaning*. Urbana: University of Illinois Press.

Ou, L.-C., Luo, M. R., Woodcock, A. and Wright A. (2004a) 'A study of colour emotion and colour preference. Part I: Colour emotions for single colours', *Color Research and Application*, 29, pp. 232–240.

Ou, L.-C., Luo, M. R., Woodcock, A. and Wright A. (2004b) 'A study of colour emotion and colour preference. Part II: Colour emotions for two-colour combinations', *Color Research and Application*, 29, pp. 292–298.

Sivik, L. (1970) 'Om Färgers Betydelse' [English Summary: Colour Connotations and Perceptive Variables]. Stockholm: Swedish Colour Center.

Sivik, L. (1989) 'Research on the meanings of color combinations' AIC Color 89, Proceedings of the 6th Congress of the International Color Association, 2, Buenos Aires: Grupo Argentino del Color, pp. 130–132.

Sivik, L. and Hård, A. (1989) 'On studying color combinations: some reflexions and preliminary experiments'. Färgrapport 22, Stockholm: Scandinavian Colour Institute.

Wright, B. (1962) 'The influence of hue, lightness, and saturation on apparent warmth and weight', *The American Journal of Psychology*, 75(2), pp. 232–241.