

Colour and emotion: the use of the colours of Lüscher test in the artistic field

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ABSTRACT

The Lüscher colour test was created by the Swiss psychologist Max Lüscher in 1949 and consists of several coloured patches that can be used to assess the patient's psychological state and profile. The main advantage of this test is its high usability and trustability.

After a preliminary analysis of using Lüscher colours, we set up a first perceptive test asking 20 subjects to associate adjectives with Lüscher's colours freely. This first test aims at defining if the basic colour terms defined by Lüscher and used to create psychological assessments are coherent and consistent in a free term-association test.

After this first perceptive test, we integrated Lüscher's basic colours with the ones used by Kandinskij, an artist who Lüscher's colour theories have strongly influenced. In this second test, we considered both Lüscher and Kandinskij basic colours. We asked 49 people to associate the colours with specific terms derived from the Lüscher theory, Kandinskij system and the first test.

From the analysis of these two experiments, it has been possible to demonstrate a strong coherence of specific colour-terms associations, which are consistent with the introduction of controlled colour shifts, while other colour-terms associations present a higher variability.

KEYWORDS Lüscher colours, Kandinskij, colour and culture, colour and art

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1. Introduction

The colour test was created by the Swiss psychologist Max Lüscher in 1949 and consists of the use of 8 coloured patches that should be placed on a scale of subjective preference (Lüscher, 1976). This scale allows the definition of a psychological profile of the tester. The subjective characteristic of Lüscher's test, the choice of favourite and rejected colours, and the psychic effect produced by the vision of different colours can also be found in the arts (Itten, 1970). A correspondence was sought in the colour theories of artists in the visual and cinematographic field, finding indirect conformity in contemporary painters like Vasilij Kandinskij and Yves Klein; and directors like Derek Jarman and Valerio Mieli (Bora G. et al., 2010a). The biggest match was found in Kandinskij's *Concerning the spiritual in art*, where some of Kandinskij's paintings have been identified to record the work's emotional impact on the observer (Kandinsky, 2012). We can divide the work into two sequential stages or experiments as follows.

In the first testing phase, 20 people did the Lüscher test and were asked to make a free association of adjectives to Lüscher's colours. This test aimed at answering the research question: *Are Lüscher's basic colour terms conform with the perceived emotions/sensations?* From the data obtained, we can better define the correspondence of Lüscher's colour theory to reality. In fact, for example, blue was associated with the term peace and calm, as Lüscher said, and as also reported in a large body of scientific literature (Valdez & Mehrabian, 1994).

From this point, considering the strong influence of Lüscher's colour theory in art (e.g., Kandinskij, Klein, Mieli), we conducted a second perceptive test. We asked 49 people to associate specific colour terms derived from the first experiment, Lüscher's colour theory and Kandinskij's theory, with colours extracted from Lüscher's test and Kandinskij's works of art. The aim of this second experiment is to answer the research question: *How much (perceptually) consistent is Lüscher's test?*

1.1. Lüscher colour test and its influence on art

The colour test by Max Lüscher is composed of eight coloured patches; each colour is associated with a particular meaning. This test's advantages are the administration speeds, universal validity and good reliability. Eight coloured cards are used, which the tester sets to scale of preference. From the colour, they prefer the less appreciated. This scale is the first step for interpreting the test result, given through the consultation of the tables to analyze the functions. The colour does not change based on meaning, but the position in the scale altered the interpretation of the tester's personality.

Lüscher's colours theory is based on the psychophysics effect produced by the sight of a specific colour.

These eight colours are divided into primary colours (blue, yellow, red and green) and additional colours (purple, brown, grey, and black). The primary colours usually stay at the beginning of the preference scale. If this does not happen, it can indicate psychological and physical stress in the patient. Psychologists and psychiatrists use this test to help highlight the tester's personality (O'Connor, 2011; French, C. A. et al. (1972)).

State of the art on the use of Lüscher's test was carried out and allowed us to analyze the links between the colours of the psychological examination, with the colours used by artists to arouse the same emotions as those defined by Lüscher.

The conceptual framework for colors's interpretations was found by Lüscher in German Romantic theory, in Goethe's *Farbenlehre* (Theory of Colours) of 1810. At one point in the first German edition of his book, published on the anniversary of Goethe's birth in 1949, Lüscher even introduced the ancient and medieval notion of the correspondence of the four humours and the four elements, with one of the sets of colours attributed to them. Goethe and his fellow-poet Friedrich Schiller had been working along similar lines at the close of the eighteenth century. The Lüscher system certainly rests on what seems to be a universal urge to attribute affective characters to colours, and it must be taken at the very least as an important modern manifestation of that urge (John Gage, 1999)

Some correspondence can be found in the theories about colours by some artists in pictorial and cinematography (e.g., Derek Jarman and Valerio Mieli), as well as in contemporary painters (e.g., Vasilij Kandinskij and Yves Klein). In this contest one of the most interesting correspondences can be found in Kandinskij's work *Concerning the spiritual in art (1910)*, that includes perhaps the most wide-ranging body of colour-ideas for modern artists.

Vasilij Kandinskij is considered the father and theorist of abstract painting. For him, colours are the key to interpreting his paintings, and he thinks there is a link between art and the spiritual dimension. Kandinskij describes colours as sensations and feelings. Kandinskij's paintings are a striking example of Lüscher's theory because they are abstract and predominate colour and shape, whereas the narration it's only suggested and subjective. Lüscher's influence on Kandinskij, the correspondences and differences in their colour theories, and the universal recognition of their works, have been the

basic elements of this study to assess the consistency of Lüscher's colours.

2. Materials and Methods

2.1. Basic colour terms

The Lüscher's colours are divided into primary colours (red, green, yellow and blue) and auxiliary colours (purple, brown, grey and black). As stated in *Il Test dei colori* by Max Lüscher, blue represents peace, calm, contemplation, and calming effect on the Central Nervous System. The body starts to relax, and psychologically blue increases vulnerability, tranquillity and the satisfaction of being in peace.

Green represents elastic tension, work, perseverance, tenacity, constancy and resistance to changes. Its emotional content is pride.

The test's red presents a point of yellow that forms orange, representing a physiological condition of energy consumption. Red speeds up blood pressure and increases the respiratory rate. Red is the expression of the life force and nervous activity. Red is impulsive, desire to win, active action, impact and willpower. Its emotional content is desire.

Yellow is the brightest colour of the test and means light and happiness. Yellow increases blood pressure, frequency of pulsations and breathing, similar to red. However, it is less stable in this action. Its main characteristics are brilliance, reflexivity, radiant qualities, and joy. Yellow express uninhibited affectivity and opening. It corresponds symbolically to the pleasant heat of the sun.

Purple is a mix of blue and red. It links the impulsive conquest of red with the gentle surrender of blue, representing identification. Purple can mean intimacy and erotic fusion or lead to an intuitive and sensitive understanding. The attitude of desire satisfaction can also mean identification as an inability to differentiate or an unresolved sway, which can both create irresponsibility.

The brown of the test is a dark yellow-red. Brown stays in the indifference zone of the colour scale. The extroverted vitality of red is reduced by its darkness. With brown, the vitality becomes passive, sensory and receptive.

The Lüscher's grey is neutral, neither subject nor object, neither inner nor outer, neither tension nor relaxation. With its unique no-involvement characteristic, grey contains an accentuated hiding element. Grey is not an occupied territory but a border as no man's land.

Black is a negation of colour. Black negation represents renunciation, complete capitulation, or abandonment and strongly influences the choice of other colours, refunding

its character. The "no", in opposition to the "yes" of white, represents the absolute limit beyond which nothing is left.

Considering now, Kandinskij's theories expressed in *Concerning the spiritual in art*, colours are often intended as in movement and relation to shapes. If we extract the given meaning of each colour, blue is related to the sky. Blue represents depth and peace with a divine purpose. In Kandinskij's theory, also green represents peace and relaxation, but in a satisfying way, more terrain if compared with blue. Red is intended as the colour of vitality and agitation and is considered less superficial than yellow. Yellow is considered the colour of youth and excitement, which can tend to madness.

Kandinskij considers purple like a cool red, which is sad and soft. Brown is the colour of the absence of dynamism and is obtuse and tough. Similarly, grey is the colour of steadiness and restrictions. In conclusion, black is a non-colour, a way to turn off all the other colours.

We can find some correspondences and differences by considering this general analysis of Lüscher's and Kandinskij's colour theories. First, we must assume that Lüscher refers to specific colour shades, while Kandinskij expresses views on pure colours, which are often considered in relation to the space or each other. This difference reflects on the associated colour terms, which present slight variations, especially for blue, yellow and green. In particular, green is the colour which shows the highest differences since, for Lüscher, it is linked to tension and dynamism, while for Kandinskij is linked to relaxation and peace.

Nevertheless, the similarities between words and meanings are noticeable. Blue is for both related to a celestial elevation, infinity, divine and deepness. Red is a vital and dynamic colour, as well as yellow. Purple is considered sensual and erotic, brown is linked to inhibition, grey to neutrality and black to denial.

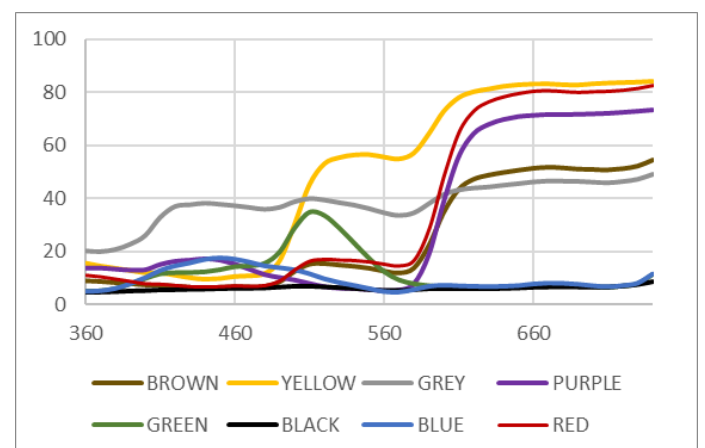


Fig. 1 Reflectance spectra of Astrolabio's colour patches.

The similarities and coherence in some colour meaning is extremely relevant and has been the base for our experiments.

2.2. Colour analysis and extraction

The colour patches used in this experiment are from Lüscher's *Il test dei colori* edited by Astrolabio. The coloured patches included in the book have been analyzed with a CM2600d spectrophotometer by Konica Minolta, and the data have been analyzed with the software Spectra Magic Nx Pro (see Fig. 1).

The extracted reflectance spectra have been converted in CIE XYZ values (2° standard observer, D65 standard illuminant) and then in sRGB colour space (see Table 1). The original patches from the book were used in the first experiment (Section 3.1), and in the second experiment (Section 3.2) have been used the derived digital patches in sRGB (Oleari C., 2008).

In the second perceptual experiment, the digital reconstruction of Lüscher's colours has been combined with the primary and auxiliary colours digitally extracted from three of Kandinskij's works:

- Several Circles, 1926, New York, Guggenheim Museum.
- Colour Study. Squares with Concentric Circles, 1913, Monaco di Baviera, The Städtische Galerie im Lenbachhaus.

- Composition VIII, 1923, New York, Guggenheim Museum.

The sRGB coordinates of the digital versions of those paintings are reported in Tab. 1. A similar experiment has been presented in (Malfatti, M., 2014), but in that case authors focused also on the relation shape-colour.

3. Experiment

3.1. Free colour terms association

In the first perceptual experiment, we asked 20 people (ages between 5 and 81) to freely associate 8 colour terms to each basic Lüscher's colours. The test was performed in person using the 8 colour patches from the book *Il test dei colori*. To do not influence the participant, we asked to each one: "*Senza fretta, ma istintivamente di i primi 2 aggettivi che ti sembrano emozionalmente legati a questo colore*" (Without any rush but instinctively say the first 2 adjectives that seem emotionally linked to this colour).

The adjectives from the participants have been recorded and ordered depending on their frequency. Subsequently, we compared the adjectives expressed by the subjects with Lüscher's terms associated with each colour (see Table 2).

Tab. 1 sRGB coordinates derived from Astrolabio's reflectance spectra and from the official photographs of Kandinskij's paintings.

	RED	GREEN	BLUE	YELLOW	PURPLE	BROWN	GREY	BLACK
Astrolabio colour patches								
R	211,4	-78,35	65,66	229,87	198,78	174,71	170,71	65,5
G	106,27	131,4	75,97	195,15	56,4	102,55	163,39	69,8
B	66,71	106,86	118,88	69,8	114,18	69,83	169,55	71,59
Several Circles, 1926, New York, Guggenheim Museum								
R	179		25	205	177	93	186	18
G	25		48	195	133	55	182	22
B	51		98	71	152	40	207	27
Colour Study. Squares with Concentric Circles, 1913, Monaco di Baviera, The Städtische Galerie im Lenbachhaus								
R	237	79	51	239	116	156	90	69
G	64	145	73	196	106	88	91	59
B	16	73	154	23	148	64	92	56
Composition VIII, 1923, New York, Guggenheim Museum								
R	182	85	91	227	130	148	156	34
G	29	125	143	183	109	89	156	32
B	5	83	162	68	156	30	127	33

Tab. 2 Lüscher and Kandinskij terms associated to each analyzed color.

Colours	Lüscher	Kandinskij
Blue	Serenity, peace, infinity	Depth, intensity, peace
Red	Intense excitement	Envelop, vital, restless
Yellow	Alive, light, cheerfulness	Madness, excitement
Green	Elastic tension, will, perseverance, firmness, constancy, resistance, pride, superiority	Peace, calm, relaxing, beneficial for human.
Purple	Identification, eroticism, desire, irresponsibility, charm	Sensual, soft, sad
Brown	Indifferent, inhibited	Inhibition
Grey	Nothingness, neutrality	Still, hopeless, strict
Black	Colour denial, end, waiver, abandonment	Dryness, eternal silence, non-colour

3.2. Defined colour terms association

In the second perceptual experiment, we asked 49 people to freely associate 11 colour terms derived from Lüscher's colour theory, Kandjnskij's works and the first experiment to each basic colour derived from Kandjnskij's selected paintings. The test was performed online using Google Forms, showing the participants a colour-term combination and asking them to assess the appropriateness of the association. For example, for the green from the painting *Composition VIII* we asked, "On a scale of one to ten, how much *determination* does it give you?" or "On a scale of zero to ten, how much *vitality* does it give you?" or "On a scale of zero to ten how much *relaxing* does it give you?". Testers had to assign a number, between zero and ten, to each question. The answers were collected in graphs, and the results were analyzed.

4. Results

4.1. Free colour terms association

The results of the first perceptual experiment are:

BLUE: deep (15%), peace (15%), calm (15%), nocturnal (10%), intense (10%), infinity (10%).

YELLOW: sunny (35%), cheerfulness (15%), summery (15%), bright (15%), tenderness (10%).

GREEN: vital (25%), lively (10%), maritime (10%), hope (10%), brilliant (10%), thoughtless (10%), brightness (10%).

RED: warm (20%), spring (10%), happy (10%), hot (10%), playful (10%), enjoy (10%).

PURPLE: cheerfulness (20%), feminine (20%), happiness (15%), lively (15%), wellness (10%), joy (10%).

BROWN: sad (10%), warm (10%), wet (10%), tacky (10%)

GREY: tranquility (15%), boring (10%), monotony (10%), clean (10%), apathetic (10%).

BLACK: dark (20%), elegance (10%), death (10%), sadness (10%), neutral (10%), loss (10%), mystery (10%), charm (10%), empathic (10%).

4.2. Defined colour terms association

Here we report some of the most significant results from the second perceptual analysis.

For this second experiment we chose to report a frequency major than 10%. The terms we considered are derived from the correspondence of the sensation evoked by each

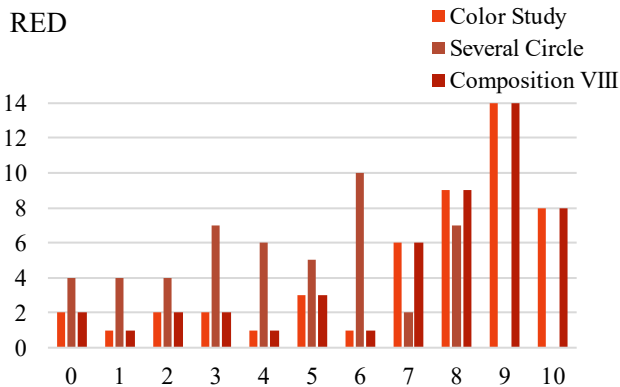


Fig. 2 Evaluation of the excitement triggered by the reds from three Kandjnskij's works of art.

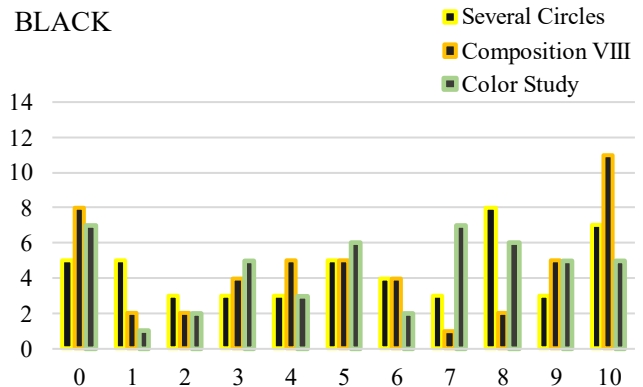


Fig. 3 Evaluation of the negativity triggered by the blacks from three Kandjnskij's works of art.

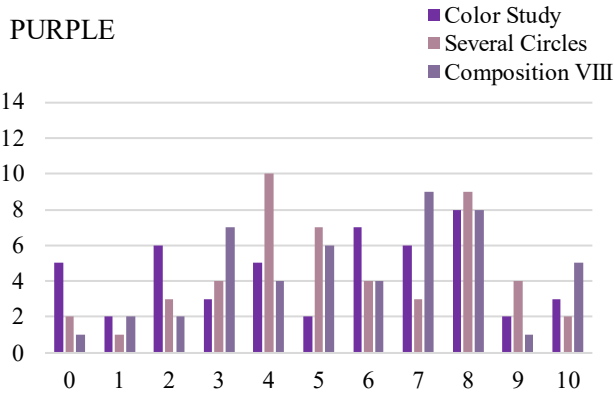


Fig. 4 Evaluation of the attraction triggered by the purples from three Kandjnskij's works of art.

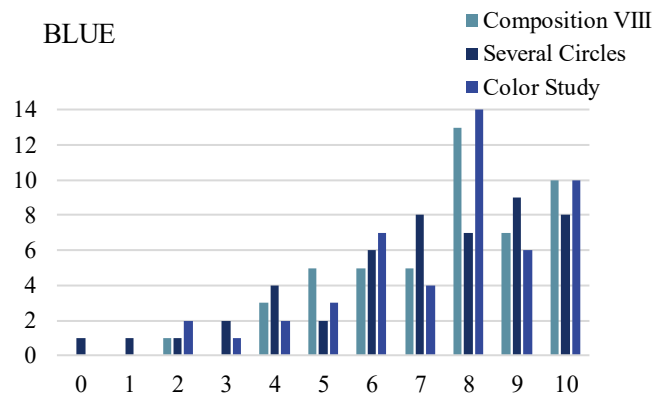


Fig. 5 Evaluation of the serenity triggered by the blues from three Kandjnskij's works of art.

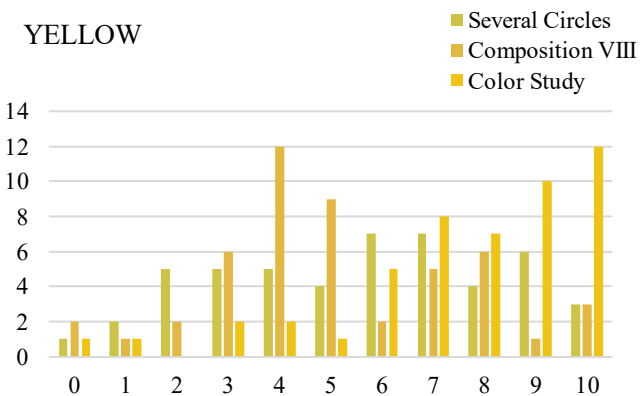


Fig. 6 Evaluation of the joy triggered by the yellows from three Kandjnskij's works of art.

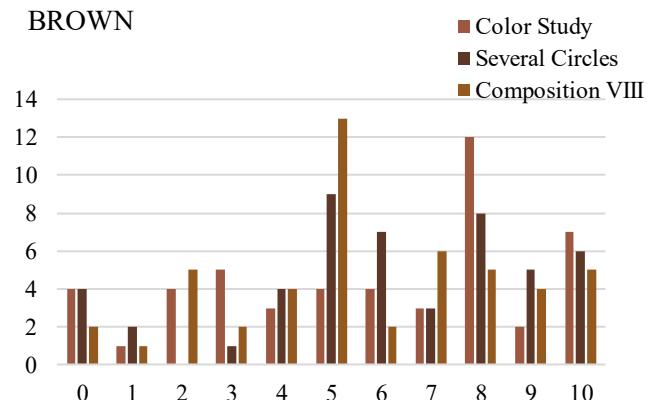


Fig. 7 Evaluation of the disregard triggered by the browns from three Kandjnskij's works of art.

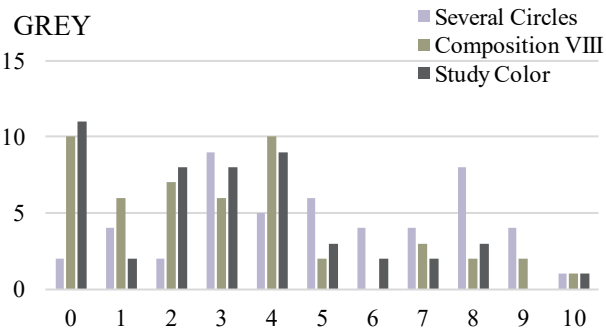


Fig. 8 Evaluation of the involvement triggered by the greys from three Kandjnskij's works of art.

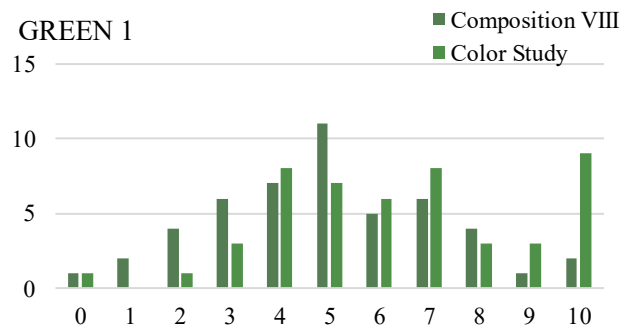


Fig. 9 Evaluation of the vitality (testers) triggered by the greens from three Kandjnskij's works of art.

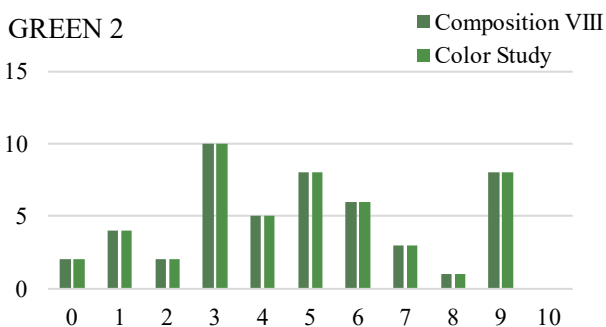


Fig. 10 Evaluation of the determination (Lüscher) triggered by the greens from three Kandjnskij's works of art.

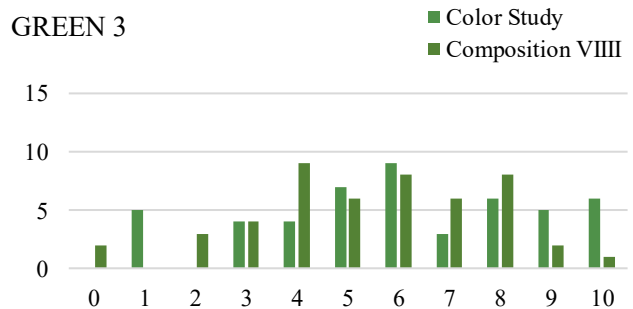


Fig. 11 Evaluation of the relaxing (Kandjnskij) triggered by the greens from three Kandjnskij's works of art.

colour between Lüscher's colour theory, Kandinskij's theory, and the results of the first experiment given by 20 testers for each color.

For the red colour, we have considered the feeling of excitement that the sight of this colour can provoke (see Fig.2).

For the black colour, we have considered the feeling of negativity that the sight of this colour can cause (see Fig. 3).

For the purple colour, we have considered the state of attraction that the sight of this colour can provoke (see Fig. 4).

For the blue colour, we have considered the feeling of serenity that the sight of this colour can cause (see Fig. 5).

For the yellow colour, we have considered the state of joy that the sight of this color can provoke (see Fig. 6).

For the brown colour, we have considered the feeling of disregard that the sight of this colour can provoke (see Fig. 7).

For the grey colour, we have investigated the state of involvement that the sight of this colour can provoke. Which is the opposite feeling provoked by the sight of this colour mentioned in the three theories (see Fig. 8).

For green colour, there is an inconsistency with the association of terms for this colour between Lüscher's theory, Kandinskij's theory and the terms associated by the testers in the first experiment. We therefore studied three types of feelings caused by the sight of this colour (see Fig. 9, Fig. 10 and Fig. 11).

For Lüscher's theory we investigated the sensation of determination, for Kandinskij's theory we chose the state of relaxing, and from the results of the first experiment we considered the sensation of vitality.

4.2.1 Additional results

In Section 4.2 we reported the color terms association with a frequency higher than the 10%. For completeness here we list briefly all the results above the threshold concerning the second experiment (i.e., defined color terms associations).

RED:

"On a scale from zero to ten how much excitement does it give you?" 7.46% of the testers gave zero, 4.75% gave one, 5.42% gave two, 6.79% gave three, 7.46% gave four, 17% gave five, 16.3% gave six, 12.2% gave seven, 17% gave eight, 12.2% gave nine and 6.79% gave ten.

BLUE:

"On a scale from zero to ten how much serenity does it give you?" 0.67% of the testers gave zero, 0.67% gave one, 2.71% gave two, 2.04% gave three, 6.12% gave four, 6.79% gave five, 12.2% gave six, 11.5% gave seven, 23.1% gave eight, 14.9% gave nine and 19.04% gave ten.

YELLOW:

"On a scale from zero to ten how much joy does it give you?" 2.7% of the testers gave zero, 2.7% gave one, 4.75% gave two, 8.83% gave three, 12.9% gave four, 9.51% gave five, 9.51% gave six, 13.5% gave seven, 11.5% gave eight, 11.5% gave nine and 12.2% gave ten.

"On a scale from zero to ten how much joy does it give you?" 2.7% of the testers gave zero, 2.7% gave one, 4.75% gave two, 8.83% gave three, 12.9% gave four, 9.51% gave five, 9.51% gave six, 13.5% gave seven, 11.5% gave eight, 11.5% gave nine and 12.2% gave ten.

PURPLE:

"On a scale from zero to ten how much attraction does it give you?" 5.42% of the testers gave zero, 3.38% gave one, 7.46% gave two, 9.51% gave three, 12.9% gave four, 10.2% gave five, 10.2% gave six, 12.2% gave seven, 17% gave eight, 4.75% gave nine and 7.46% gave ten.

BROWN:

"On a scale from zero to ten how much disregard does it give you?" 6.79% of the testers gave zero, 2.71% gave one, 6.12% gave two, 5.42% gave three, 7.46% gave four, 17.67% gave five, 17% gave six, 8.16% gave seven, 17% gave eight, 7.46% gave nine and 12.2% gave ten.

GRAY:

Remembering that the opposite meaning was used for grey. "On a scale from zero to ten how much involvement does it give you?". 15.6% of the testers gave zero, 6.79% gave one, 11.5% gave two, 15.6% gave three, 16.3% gave four, 7.46% gave five, 4.08% gave six, 6.12% gave seven, 8.83% gave eight, 4.08% gave nine and 2.04% gave ten.

BLACK:

"On a scale from zero to ten how much negativity does it give you?" 13.6% of the testers gave zero, 5.42% gave one, 4.75% gave two, 8.16% gave three, 7.46% gave four, 10.88% gave five, 6.79% gave six, 7.46% gave seven, 10.88% gave eight, 8.83% gave nine and 15.6% gave ten.

GREEN:

Three sensations were considered for the colour green. This colour is only present in two paintings. The first sensation investigated comes from Lüscher's theory. "On a scale from zero to ten how much determination does it give you?" 2.04% of the testers gave zero, 4.08% gave one, 5.1% gave two, 13.26% gave three, 12.2% gave four, 12.2% gave five, 13.26% gave six, 10.2% gave seven, 7.14% gave eight, 14.28% gave nine and 6.12% gave ten.

The second sensation investigated comes from Kandinskij's theory. On average for the colour green to the question "On a scale from zero to ten how much relax does

it give you?" 2.04% of the testers gave zero , 5.10% gave one, 3.06% gave two, 8.16% gave three, 13.26% gave four, 13.26% gave five, 17.34% gave six, 9.18% gave seven, 14.28% gave eight , 17.14% gave nine and 7.14% gave ten. The third sensation investigated comes from tester's adjectives "On a scale from zero to ten how much vitality does it give you?" 2.04% of the testers gave zero , 2.04% gave one, 5.1% gave two, 9.18% gave three, 15.3% gave four, 18.3% gave five, 11.22% gave six, 14.28% gave seven, 7.14% gave eight , 4.08% gave nine and 11.2% gave ten.

5. Discussion and conclusion

Considering the first test's results reported in Section 4.1 there is a strong variance in the colour-terms associations. Often, a cognitive term association (e.g., yellow – sunny; red – hot; green – hope) underlines the influence of cognitive functions regardless of emotional associations; this result can be explained by the nonlinearity of the color-emotion association as shown in the literature (Bortolotti et al., 2022; Jonauskaitė et al., 2021). Comparing these results with the colour terms used by Lüscher and Kandinskij, there is a strong accordance for specific colours while discording others (see Table 2). The blue colour is the one which presents the strongest accordance with Lüscher and Kandinskij. Among the most frequent colour terms, we have peace, infinity and intensity, as theorized by the two authors. Also, for the yellow, we have accordance among the participants and Lüscher's and Kandinskij's theories (e.g., cheerfulness and light). Considering the red, Lüscher associates to this colour an intense excitement, which can correlate with the terms happy, playful, and enjoy expressed by the test's participants. Nevertheless, this association is not completely coherent with Lüscher's theory. The green presents the most surprising results since the subjects did not associate terms related to perseverance, resistance, and tension. The test's subjects seem to agree more with Kandinskij's definitions. In fact, terms like alive, hope, and brightness can correlate with the painter's concepts of peace and relaxation. Considering the auxiliary colours (purple, brown, grey and black), black we have correspondence with the Lüscher's theory, and the adjectives given by the testers. For Lüscher we have the concept of the end and the testers give "death", whereas with the Kandinskij's theory and adjectives given by the testers there is no link. For the grey colour we didn't find a correspondence, for Lüscher grey is linked with the concept of neutrality, for Kandinskij is linked with the concept of steadiness and for testers is linked with the concept of tranquility. For the purple we have accordance among the participants and Lüscher's and Kandinskij's theories. Participants associated this color with the concept of feminine, for Lüscher's is linked with the

concept of erotism, desire and charm, and for Kandinskij's with the sensuality. These free concepts are linked. For brown there is no correspondence with the meaning given by Kandinskij or Lüscher and the adjectives given by the testers. In fact, it is the colour that provided the greatest variety of adjectives from testers.

The second perceptual test was performed to avoid the cognitive term's associations that came out in the first test and to investigate further the consistency of Lüscher's (and Kandinskij's) colour theory. The excitement associated with Lüscher to red is also confirmed by the reds extracted from Kandinskij's paintings. This colour also triggers excitement in different shades and is extracted from other contexts. This trend can also be noted for blue, which triggers serenity, and yellow, which triggers joy (also if to a lower extent for the colour extracted from Composition VIII). Considering the greens, the shade from the Colour study triggers vitality and determination, while the one from Composition VIII does not correlate well with Lüscher's terms. This disagreement between Lüscher's colour terms and the greens extracted from the paintings can identify a higher sensitivity of the subjects in green shade variations. This means that a change in the shade of green affects the subjects more than a change in red, yellow or blue. Brown triggers disregard in an average way, and grey does not trigger involvement (confirming Lüscher's theory). In conclusion, black triggers negativity just partially in Composition VIII.

The two perceptual tests presented in this paper helped us to determine that Lüscher's basic colour terms conform with the generated sensations to a greater extent for the primary colours (green excluded). Nevertheless, a further investigation that does not include the possibility of making cognitive associations will be necessary.

The experiments showed in this paper can be potentially affected by cultural factors such as symbolism associated to certain colors.

The perceptual consistency of the Lüscher test has been confirmed just for some colours (blue, red, yellow and grey), while for other colours (like green), the variation in shade causes a strong variation in meaning and associated emotions.

6. Conflict of interest declaration

Authors declare no conflict of interest.

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9. Short biography of the authors

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