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On the perceptual/linguistic origin of the twelfth basic color term in the Italian color lexicon

ABSTRACT

Color categorization involves a cognitive mechanism that assigns linguistic labels to perceived colors. In their pioneering study of 1969, Berlin and Kay proposed the existence of eleven universal basic colors, founding the *"universalist"* theory on color naming. Since then different studies have been proposed either supporting or refusing such a conjecture based on new evidence. One of the most fascinating elements of this research is the debate on the nature of the color naming mechanism: is it a predominantly *perceptual* or *linguistic* effect? An inherent aspect stemming from Berlin and Kay's conjecture is the *"weak relativist hypothesis"* concerning the emergence of additional basic color categories besides the established 11, specific to a certain language. In this paper we investigate these two issues and propose some arguments in favor of the existence of a twelfth basic color term in Italian. Following the indications of the results of our previous work, two experiments were performed, focusing on the linguistic and the perceptual aspects, respectively. Results support the hypothesis of the existence of an additional basic category named *azzurro* (light blue), as it is the case for Turkish, Greek, Russian and Maltese.

1. INTRODUCTION

The seminal work of Berlin and Kay introduced the concept of universal basic color terms (BCTs) [1], namely red, green, blue, yellow, orange, purple, pink, brown, gray, white, and black. According to their definition, color terms are operationally defined as basic only if monolexemic and psychologically salient for all speakers, but not if restricted in application to narrow classes of objects, or included in the signification of other basic color terms. They proposed that these color words act as focal points for all the basic color categories in all the languages with a developed color vocabulary. In the last decade, the restriction to eleven universal basic colors has been put into question. Some researchers provided evidence on the existence of an additional basic term in the category of blue for the Greek, Turkish, Russian and, more recently, Maltese languages [2-6]. In the same line, our work [7-15] has emphasized the need for the Italian speakers to assign the term corresponding to light blue, *azzurro*, to a separate category. In particular, in the constrained color naming experiment described in [7] participants were instructed to name samples of colors using only the eleven basic terms identified by Berlin and Kay. After performing the experiment many participants reported the uneasiness on using the term *blu* (blue) to label colors in the lighter blue portion of the spectrum. In addition, the lightness of the centroid for the *blu* category was well above the lightness of the category focal.
In order to disambiguate the role of linguistic and perceptual mechanisms in color categorization and to shed light on the existence of the twelfth category in Italian, other experiments were performed and the outcomes of these confirmed our conjecture. Here we report on both an unconstrained color listing experiment and a Stroop test with (in)congruent word/ink parings [8, 16]. We refer to [7-15,19,20] for additional information.
This paper is organized as follows. Section 2 describes Experiment 1 (color listing) and briefly summarizes the outcomes of Experiment 2 (Stroop test). Section 3 illustrates the results and Section 4 presents the conclusions.

2. METHODS

2.1 EXPERIMENT 1: COLOR LISTING

The color listing experiment was designed to determine whether there is a measurable difference in the spontaneous recall frequency of names associated with basic colors with respect to other color categories. In this way, the recall frequency can be considered as a further indication of the semantic difference between basic and non-basic colors and thus of the *"basicness"* of a given color name. Accordingly, the recall frequency for the term *azzurro* was assessed by a color listing experiment.

A questionnaire was prepared and submitted to the informants participating in the experiment. It consisted of two parts. In the first, demographic data were requested in order to enable the identification of other possible factors influencing the recall rate (e.g. gender, age). The second part was devoted to the color listing task. The requested personal data were: gender, age, education, job, hometown and knowledge of foreign languages or Italian dialects. The participants were also asked whether they had particular involvement in color management in their everyday life (either for their professional activity or in their spare time). Thirty-nine people aged between 15 and 62 volunteered for the experiment. All of them were native Italian speakers. The task consisted of listing all the known color names freelyand without constrains on the type and number of names provided. There was no time limit and response time was not recorded.

2.2 EXPERIMENT 2: STROOP TEST

The Stroop test brought a new argument in favor of the weak relativity hypothesis providing additional evidence of the existence of at least a twelfth color category in the Italian language.
The Stroop test was introduced in 1953 by John Ridley Stroop [16] and is based on the assessment of the reaction time in a color naming task. Basically, color name and color ink pairs are shown in either congruent (color name corresponds to ink color) or incongruent (color name and ink color are different) parings. Stroop demonstrated that in the second case (e.g. red ink and green word) the naming of the ink color takes longer and is more prone to errors than in the first (green ink and green word).
The aim of the experiment was to assess whether naming the *azzurro* (light blue) ink color would take longer than naming the *blu* (dark blue) ink color if both were paired to *blu* color word. Five experiments were performed for assessing the reaction times in different congruent/incongruent conditions using different combinations of color names and ink color parings in order to avoid the interference from other factors possibly biasing the results of the experiment. In particular, the linguistic nature of the mechanism was investigated by separately performing the experiment on the *verde* (green) and the *blu* (blue) categories, respectively. In the first, regarding the *blu* category, six ink colors were used: dark blue, light blue, red, yellow, purple and pink. The six colors were paired with four colors names *rosso*, (red), *blu* (blue), *viola* (purple) and *giallo*, (yellow), resulting in 24 possible combinations (e.g. red ink – *rosso* word, red ink – *blu* word etc.).
In the second experiment, regarding the green category, the two blue ink colors were replaced by two green colors that were equidistant in lightness and the word *blu* was replaced by the word *verde*, while keeping all the other conditions unchanged. The choice of green was motivated by the fact that the perceived colors corresponding to the green category cover a large portion of the spectrum including both high and low lightness values, as it is the case for the English blue.
The underlying hypothesis was that statistically significant mean reaction time difference for low and high lightness ink colors when paired to the congruent color word (*blu* and *azzurro*, respectively, for the blue category and *verde* for the green category) would have provided evidence in favor of the predominance of a linguistic rather than a perceptual mechanism.
Alternative: The underlying hypothesis was that low and high lightness ink colors, when paired with incongruent color words (*blu* and *azzurro*, respectively, for the blue category and *verde* for the green category) would provide statistically slower mean reaction times than those for the congruent pairs, thus supporting a linguistic rather than perceptual mechanism.
In other words, our claim was that if the reaction time was the consequence of a predominantly perceptual effect, the same trend would have been observed for the two categories. Conversely, a different trend would have supported the linguistic hypothesis, since in this case the *blu* and *verde* categories would have revealed a different underlying linguistic mechanism affecting reaction time.
The third, fourth and fifth experiments were aimed at avoiding the influence of other confounding factors. The Munsell coordinates and the lightness of the colors used were as follows: red 7.5R 5/20, L*=51.85, dark blue 5PB 1/10, L*=12.63, light blue 5PB 6/14, L*=60.91, yellow 5Y 9/12, L*=89.28, purple 2.5P 3/18, L*=30.64, pink 7.5RP 7/10, L*=44.61, dark green 10GY 1/10, L*=13.14, light green 10GY 6/14, L*=61.38. We refer to [8] for more details.

3. RESULTS

3.1 EXPERIMENT 1: COLOR LISTING

Results confirmed the psychological salience of the 11 basic color terms. As shown in Table 1, the basic terms occupy the first positions and reach very high response frequencies. The *bianco* (white) category was named by all 39 participants, while the basic term recalled with the lowest frequency (33 participants) was *viola* (purple). Interestingly, the word chosen to designate light-blue was *azzurro*, which at that time was not considered to be a basic term, reaching frequencies similar to those of other basic terms (35 participants). This supports the hypothesis that Italian speakers do need a term

denoting that particular area of the color space and *azzurro* seemed to be the best candidate.
Beyond *azzurro*, other terms denoting approximately the same region reached good frequencies, for instance *celeste* and *turchese*. After *viola* there was a sharp variation in the naming frequencies. The total number of provided names was 136. The 12 colors ordered according to decreasing frequency of recall were white *bianco* (white), *rosso* (red), *giallo* (yellow), *nero* (black), *verde* (green), *marrone* (brown), *blu* (blue), *rosa* (pink), *arancione* or *arancio* (orange), *azzurro* (light blue), *grigio* (grey) and *viola* (purple). The light blue color comes in this list before two basic colors, gray and purple, which highlights its psychological saliency in the Italian language. Interestingly, for other very wide regions of the color space, like that for green, just one basic term seems to be sufficient.
In this experiment almost every subject (90%) proposed an alternative name for the blue region (beside blue). Interestingly, this was not the case for green (48% only). Moreover, the additional terms proposed for blue were mainly simple terms with high consensus, while the terms for green were compound terms denoting objects and reaching very low frequencies (about 30 such names were provided).
As can be seen in the table 1, agreement on an additional term denoting the green region was not reached, in contrast to the case of the blues. There are no simple names widely implemented and known, like *azzurro*, that might be used in order to enlarge the lexicon referring to the green region. This is probably why the few participants who used lightness modifiers (*chiaro* and *scuro* - light and dark) applied them to the *verde* term.
A discussion on the existence of a twelfth color class was initiated by Boynton and Olson (B&O) in [17] and reconsidered by Sturges

Table 1 - Frequency recall of colors

Color Name	Num.	Color Name	Num.	Color Name	Num.
bianco	39	giallo canarino	3	bianco sporco	1
rosso	37	vermiglio	3	corallo	1
giallo	37	rosa cipria	2	rosa antico	1
nero	37	verde oliva	2	rosso sangue	1
verde	36	(rosso) mattone	2	bianco perla	1
marrone	35	grigio perla	2	rame	1
blu	35	ecru	2	verdemare	1
rosa	35	senape	2	grigioverde	1
arancio/arancione	35	blu di prussia	2	topazio	1
azzurro	35	rosso scarlatto	2	giada	1
grigio	34	bruno	2	carta da zucchero	1
viola	33	rosa carne	2	terra	1
lilla	17	prugna	2	lavanda	1
(giallo) oro	17	acqua marina	2	violetto	1
(grigio) argento	16	ghiaccio	2	grigio fumo	1
beige	15	cobalto	2	blu aviazione	1
fucsia	15	sabbia	2	rosa pallido	1
(giallo) ocra	14	(verde) cromo	2	verde muschio	1
celeste	13	giallo paglierino	2	verde vescica	1
turchese	12	verde mela	2	verde montano	1
indaco	12	grigio topo	2	inox	1
bordeaux / bordo'	12	crema	2	ottone	1
(rosso) magenta	10	verde militare	2	nero grafite	1
(rosso) porpora	10	verde prato	2	nero di seppia	1
Blu oltreoceano-mare/oceano	8	verde marcio	2	bianco di zinco	1
terra di siena (bruciata)	8	giallo arancio	1	blu ginepro	1
verde smeraldo	7	aragosta	1	rosso bandiera	1
(bianco) panna	7	rosso vivo	1	rosso rubino	1
verde acqua	6	rosso pompadour	1	giallo di napoli	1
(rosa) salmone	6	bruno giallo	1	verde bandiera	1
giallo limone	6	blu di sevres	1	verde vagone	1
amaranto	6	blu cina	1	blu navy	1
ciano	5	pervinca	1	khaki	1
ciclamino	5	verde foglia	1	testa di moro	1
avorio	5	verde cinese	1	grigio polvere	1
(grigio) antracite	5	verde imperiale	1	castano	1
rosso carminio	5	verde nero	1	verde bosco	1
bronzo	5	verde giallo	1	granata	1
(verde) petrolio	4	verde ftalo	1	castagno	1
pesca	4	porpora rosa	1	pero	1
verde pisello	4	ocra rossa	1	ciliegio	1
blu notte	4	verde reale	1	caramello	1
vinaccia	3	verde mirto	1	menta	1
cremisi	3	azzurro marino	1	giallo vivo	1
nocciola	3	verde fluorescente	1		
verde acido	3	verde pino	1		

and Whitfield (S&W) in [18]. Although our experimental procedure and method were different, their main findings were confirmed as detailed in the following sections. Interestingly, the same conclusion was supported by experimental evidence obtained in a purely linguistic framework.

Comparison with B&O and S&W

Basic color terms: The psychological saliency of the eleven basic color terms was confirmed by the experiment. Recall frequencies drop from 84.6% (last basic term) to 43.5% (first non-basic term). The most important difference with respect to S&W was that in our experiment a twelfth potential basic color term had appeared (azzurro). This is most probably due to the cultural difference (Italian versus English). In [17,18] the authors foresaw the existence of a twelfth basic color for the English language based on the finding that *"cream"* (B&O) and *"peach"*. (S&W) obtained low response times and a fairly high consensus with respect to the other non-basic color terms. These two hypotheses were weakened by two factors: (i) strong evidence in the data was missing (response time and consensus), and (ii) the data led to a different indication for the missing name, which is supposed to be unique.

On the contrary, the current experiment has provided a clear indication from the linguistic point of view, since the name *azzurro* has a higher recall frequency than other basic terms. On top of this, such a term, corresponding to the light blue region, is in line with recent findings regarding other languages like Greek, Turkish, Russian and Maltese [2-6]. It is noteworthy that Berlin and Kay proposed a hierarchy in color names that could in principle enclose such a term without losing generality.

The different paradigm used in our experiment highlights another important difference concerning achromatic colors. B&O did not report on achromatic colors because of their poor representation in the OSA-UCS space. For S&W achromatic colors appeared in the last positions (in terms of consensus and response time) if compared to the other basic color terms. In our experiment, *bianco* (white) and *nero* (black) lie at the top of the basic color terms (in terms of frequency of recall), in agreement with the hierarchy proposed in by Berlin [1], while this was not the case for B&O and S&W. Even more interestingly, the six Hering primaries (red, green, blue, yellow, white, black) appear shortly after, followed by the other basic color terms (gray appears in the last position). We consider this as a strong indication that our results have a solid psychological correlate that might include perception and that seems to be stronger than for the other considered studies.

Non-basic color terms: The results of the three studies agree in this respect and highlight similar findings despite the different paradigms and languages. An interesting point is that non-basic terms with the highest recall frequencies are the same as those in the other two studies. They seem to refer to the regions where basic color terms are rarely used, namely those between white and brown/yellow ("cream, mustard, beige" for S&W, *oro, beige, ocra* in our experiment) and between white and purple/red ("lilac, violet, burgundy" for S&W, *lilla, fucsia* in our experiment).

Overall, our results provide a clear indication towards the linguistic point of view, since the name *azzurro* features a higher recall frequency than many other basic terms, while confirming the saliency of the eleven basic color terms.

Impact of other factors

Gender - Several studies have shown that women tend to produce and use more color names than men. We tried to investigate the existence of a correlation between the participants' gender and the number of terms provided. Our participants were 11 males and 28 females. The average number of terms named by males was 22.63, against 20.42 for females. In order to better investigate the issue, the standard deviation of the parameter was measured, resulting in 9.11 for males and 9.47 for females. The distribution of the values in the two groups is quite similar. The results of our experiment show analogous numbers of terms provided regardless of gender. However, a gender-balanced sample would have been required for robust conclusions. Statistical significance?

Age - Participants were aged between 15 and 62. A correlation between age of participants and number of terms provided was observed. The participants were organized into three age groups (<30; 30-45; >45). While the first and the last ones provided approximately the same number of color names, the other one (30-45) provided a significantly lower number of terms. You have to include the p value.

Color experience - Participants were also divided into two groups according to their involvement in color matters. One group included people who have had someinvolvement in color (regardless of the involvement in nature), while the second group included people who have not. Participants who reported an involvement provided a significantly higher number of color names. Results are summarized in Table 2.

Finally, the recall frequency for non-monolexemic names using lightness modifiers is given in Table 3, where chiaro stands for light, scuro for dark, and vivo for vivid.

Overall, the experiment confirmed the special status of the 11 basic color terms, but also

Table 2 - Mean and standard deviation of frequencies over gender, age and color experience.

	Gender		Age			Color Experience	
	M	F	<30	30-45	>45	Si	No
μ	22.63	20.42	21.23	17.07	25.33	26.63	15.75
σ	9.11	9.47	8.4	6.7	12.22	10.22	3.68

Table 3 - Number of recalls of compound names using a lightness modifier. Chiaro stands for light, scuro for dark, vivo for vivid.

Lightness modifiers											
verde chiaro	verde scuro	marrone chiaro	marrone scuro	grigio chiaro	bruno scuro	blu chiaro	blu scuro	giallo chiaro	giallo scuro	rosso vivo	giallo vivo
5	2	2	2	1	1	1	1	1	1	1	5

provided evidence of the need of a twelfth color name, in the Italian language, at least: *azzurro*.

3.2. EXPERIMENT 2: STROOP TEST

Results support the hypothesis that two blue basic color terms do exist. The dark and light blue colors used in the experiment, having the same hue but different lightness, appear to belong to two different color categories. A Student's t-test ($p<0.05$) showed that for every possible pairing (color ink and color word) the *blu* color word had significantly shorter reaction times when paired with dark blue ink than in all other conditions (Fig. 1, left plot). This means that the participants name more quickly the dark blue rather than the light blue ink color if both are paired with the *blu* color word.

In the control experiment, the t-test for each possible combination of stimuli (ink color and color word) showed that the color word *verde* has significantly shorter reaction time when paired either to light or dark green colors than in any other condition (Fig. 1, right plot).

4. CONCLUSIONS

Our studies brought evidence in favor of the hypothesis of the existence of a twelfth basic color class in the Italian language in the light blue (perceived) color range named *azzurro*, as well as in its linguistic reference to perceived colors. Both the color listing and the Stroop tests supported such a conjecture. No other factors (age, gender, color experience) resulted in having a significant impact on the outcomes of the two experiments. However, this issue deserves further investigation.

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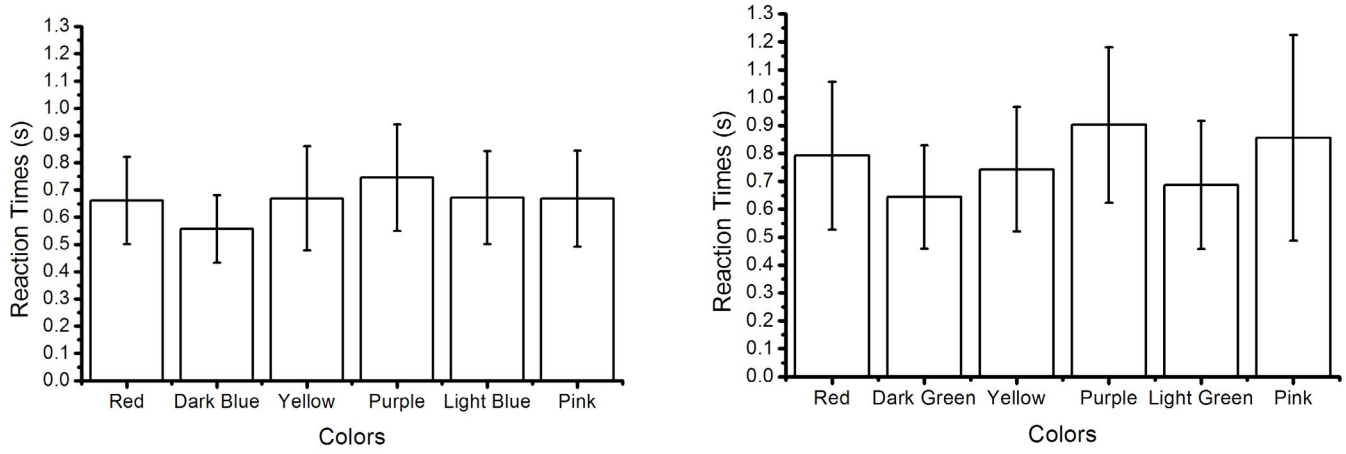
Figure 1 - Average reaction time for the blu (on the left) and verde (on the right) term.



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