What's in a Colour? Studying and Contrasting Colours with COMPARA

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Abstract

In this paper we present contrastive colour studies done using COMPARA, the largest edited parallel corpus in the world (as far as we know). The studies were the result of semantic annotation of the corpus in this domain. We chose to start with colour because it is a relatively contained lexical category and the subject of many arguments in linguistics. We begin by explaining the criteria involved in the annotation process, not only for the colour categories but also for the colour groups created in order to do finer-grained analyses, presenting also some quantitative data regarding these categories and groups. We proceed to compare the two languages according to the diversity of available lexical items, morphological and syntactic properties, and then try to understand the translation of colour. We end by explaining how any user who wants to do serious studies using the corpus can collaborate in enhancing the corpus and making their semantic annotations widely available as well.

1. Motivation

Colour is one of the semantic domains more used in linguistic argumentation over the status of language vs. cognition, and language vs. world. See for example Berlin & Kay's (1969) influential work, and its support or criticism in works by Pinker (1994) or Sampson (2005), or Gärdenfors (2000). It is also a prime example of morphological creativity, diachronic change and cultural differences. See e.g. Cheminée et al. (2006) for the latter. This is why we started our semantic explorations of COMPARA by the colour domain. As far as we know, COMPARA (Frankenberg-Garcia and Santos, 2003)¹ is the largest edited parallel corpus in the world, and after the revision of its automatic syntactic annotation (for nouns and adjectives; verbs are under way) in Portuguese (Santos and Inácio, 2006; Inácio and Santos, in progress), and the beginning of the same process in the English side, we thought it was high time to use it for semantic studies as well.

2. The Annotation Process

Since there are currently no available automatic semantic analysers that we know of, we decided to use a lexically-driven approach followed by human revision. After having manually extracted all the words denoting colour from several lists of words automatically extracted from COMPARA, we marked automatically all colour words in COMPARA² on both sides (4,774 in Portuguese and 4,808 in English), amounting to 428 Portuguese different forms (279 different lemmas) and 483 different forms in English. This was encoded in the sem attribute for query purposes (we use CQP (Christ et al., 1999; Evert, 2005) for corpus encoding in the DISPARA system; see Santos (2002) for more details). So, to retrieve colour instances in COMPARA the query should be [sem="cor:*"] or [sem="colour:*"], for

¹ www.linguateca.pt/COMPARA/
² We have used the version 10.0.2 of COMPARA for the data presented in this paper, with 1.5 million words in each language.
in Silve et al. (in progress).

| Attribute                              | Port | Engl |
|----------------------------------------|------|------|
| cor/colour                             | 3,412| 3,505|
| cor:raça/colour:race                   | 676  | 641  |
| cor:humana/colour:human                | 371  | 276  |
| cor:vinho/colour:wine                  | 16   | 16   |
| cor:original/colour:original           | 161  | 260  |
| cor:cor:raça/colour:colour:race        | 6    | 43   |
| cor:cor:humana/colour:colour:human     | 2    | 1    |
| cor:cor:original/colour:colour:original| 88   | 8    |
| cor/0/colour_0                         | 35   | 51   |
| cor_naomaduro/colour_unripe            | 5    | 6    |

Table 1: Colour categories in PT and EN (originals and translations).

By this initial comparison we can see a large difference in the use of words belonging to the `colour:original` category. However, this difference is somewhat softened if we take into consideration the number of vague instances (vagueness between colour and colour:original). Another line of Table 1 that stands out is cor_0/colour_0 (vagueness between colour and not colour) where we can see much more instances in English (51) than in Portuguese (35). An example in English is "...blue face" that can indicate sadness or change in the colour of the skin. In Portuguese a good example is "...o verde da natureza" which can mean all the greenery existing in nature (not necessarily green) or just the range of the green colour nature presents.

By comparing the two languages in its entirety, we observe that in Portuguese there are slightly more colour words related to race than in English, and significantly more human words in Portuguese. These two differences can be largely explained by the fact that we did not consider Negro a colour word in English, and by the fact that apparently the skin/hair field in Portuguese is more developed, as we will discuss in section 5. But also words like morena are rendered by dark, which denote shades in English and we did not mark as colour.

Table 2 shows the distribution of the colour categories, but only for the original texts. Now, instead of representing the language used to describe the same states of affairs (assuming that the two versions of the texts represent roughly the same stories), we can compare what (the particular set of) English original texts attend to as opposed to (the other particular set of) Portuguese original texts. Interestingly, we note that English-speaking authors use more words that were classified into the categories `colour:race` and `colour:human` than Portuguese-speaking authors. Also curious is the imbalance regarding the category `colour:original`. Apparently words in English that have a colour reference in their origin but have gone beyond the mere colour sense are much more frequent. (This may however be also due to different subjective criteria of the different annotators, and has to be investigated further.)

### 2.1. Specifying the Colour Category Further

We also created manually specific attributes to classify colour words, i.e., we grouped all straightforward colour words into seventeen colour groups for each language -- see below -- in order to do finer-grained comparisons between authors and languages. The colour groups are Black/Preto and White/Branco (representing the outermost points of the colour spectrum), Blue/Azul, Yellow/Amarelo, Red/Vermelho, Orange/Laranja, Green/Verde, Purple/Roxo, Brown/Castanho, Beige/Creme, Pink/Rosa, Grey/Cinzento, Gold/Dourado and Silver/Prateado (representing the most significant and predominant primary and secondary colours), Multiple/Multipla (to classify compound nouns where one unique colour reference cannot be identified, for instance, grey-blue and yellow-red; not for cases where the main colour reference is explicit, like in bluish-green or greenish-yellow), Unspecified/Naoespecificada (to indicate colours that are implicitly present in the text but not explicitly named, and to mark the cases in which there is reference to many colours as in for example, colourful or different-coloured). Finally, we used the group Other/Outras to encompass all colours that do not fall easily into other categories (or about which there was no consensus in the annotation team).

Examples of members of each group (encoded in the attributes cor or colour for Portuguese and English respectively) can be seen in Tables 3 and 4. Note that this grouping is independent of part of speech. Those tables show the size (i.e., the number of different words – or types – belonging to the group), and the extent (number of instances of colour words in that group in the whole corpus), for each group as well. They are organized in decreasing order of group size: Vermelho and Red are the simple colours with most different forms (48 and 35) in the two languages, while Laranja and Orange are have the least variety (6 and 4). The main differences in the rankings of the two languages, in fact, occur in the complex categories (Multiple, Other and Unspecified).

![Table 2: Colour categories in EN and PT (source texts).](attachment:image.png)
and are apparently due to non-semantic factors, such as spelling differences or different morphological features).

| Group     | Size | Example of words belonging to the group                                                                 | Extent |
|-----------|------|--------------------------------------------------------------------------------------------------------|--------|
| Vermelho  | 48   | encarnado, purpúra, purpureamente, ...                                                                 | 427    |
| Azul      | 34   | azuis-pálidas, azula, anilada, turquesa, ...                                                             | 321    |
| Branco    | 30   | alvo, branco-sujo, esbranquiçava, ...                                                                       | 644    |
| Verde     | 32   | esverdeado, verde-azulados, ...                                                                                  | 271    |
| Amarelo   | 27   | amareleciam, amarelo-esverdeada, ...                                                                              | 178    |
| Cinzento  | 27   | plúmbeos, cinza, cinza-claro, cor-de-rato, ...                                                               | 126    |
| Castanho  | 24   | acastanhada, marrom, castanho-rosada, ...                                                                    | 142    |
| Outras    | 22   | pardo, fulvos, bronze, âmbar, ocre, malva, ...                                                                | 123    |
| Preto     | 17   | negro, enegrecido, pretume, negrissimo, ...                                                                     | 509    |
| Dourado   | 16   | ouro, dourava, douradas, douradura, ...                                                                          | 153    |
| Rosa      | 16   | cor-de-rosa, rosado, róseos, rosa-shoking, ...                                                                  | 122    |
| Naoespecificada | 15 | cor, coloridas, multicolor, coloriam, variegado, ... | 353 |
| Roxo      | 15   | violeta, lilás, arroxeou, violáceo, ...                                                                                 | 70     |
| Prateado  | 9    | platinados, prateando, platina, ...                                                                                  | 34     |
| Multipla  | 9    | verde-negra, rosa-pérola, marmorizado, ...                                                                            | 10     |
| Creme     | 8    | beges, pérola, marfim-velho, ...                                                                                  | 29     |
| Laranja   | 6    | cor de laranja, alaranjado, ...                                                                                   | 33     |

Table 3: Colour groups in Portuguese.

3. Initial Exploratory Studies

COMPARA can be used, like its source of inspiration, the English Norwegian Parallel Corpus, ENPC (Johansson & Hofland, 1994), (i) to compare two languages, (ii) to compare original and translated text in the very same language, and (iii) to compare what happens when things are translated in either direction. Furthermore, and due to the presence of several different varieties of both Portuguese and English, it can also be used as a tool for (iv) comparing varieties (provided, in all cases, that we are aware of the size of the material and do not extrapolate too wildly).

Since COMPARA includes texts from a variety of authors, it can also be used for literary studies and for comparing different styles. In Inácio et al. (2008) and Silva et al. (2008) the different behaviour among English-speaking authors and Portuguese-speaking ones as far as colour was concerned was contrasted and discussed. We also tried to assess whether there was a consistent pattern of increase in colour use with time, but the results were inconclusive.

| Group       | Size | Example of words belonging to the group                                                                 | Extent |
|-------------|------|--------------------------------------------------------------------------------------------------------|--------|
| Multiple    | 38   | black-and-white, grey-green, marbled, ...                                                                   | 57     |
| Red         | 35   | scarlet, reddish, crimson, ruby, brick-red, ...                                                                | 436    |
| Green       | 34   | greenish, olive, emerald, pale-green, ...                                                  | 265    |
| White       | 30   | snow-white, whitened, white-collared, ...                                                                    | 633    |
| Blue        | 29   | pale-blue, sky-blue, aquamarine, blue-checked, ...                                                              | 323    |
| Grey        | 29   | gray, greyed, pearl-grey, ashen, ...                                                                               | 171    |
| Unspecified | 28   | colour, colored, colourful, multicoloured, ...                                                                    | 353    |
| Brown       | 28   | auburn, muddy-coloured, mustard-brown, ...                                                                       | 189    |
| Pink        | 23   | rose-colored, pinkish, dusty-pink, ...                                                                               | 126    |
| Black       | 21   | black, blackened, coal-black, ...                                                                                 | 487    |
| Yellow      | 21   | yellowed, yellowish, ...                                                                                        | 177    |
| Other       | 14   | bronze, amber, ochre, copper, sand-colored, ...                                                                    | 41     |
| Gold        | 9    | golden, ginger-gold, ...                                                                                        | 145    |
| Purple      | 9    | violet, lilac, violet-coloured, ...                                                                                  | 95     |
| Beige       | 7    | cream, ivory, pearl-coloured, ...                                                                                  | 33     |
| Silver      | 5    | silvered, silvering, ...                                                                                        | 40     |
| Orange      | 4    | orange-colored, carrot-colored, ...                                                                                  | 33     |

Table 4: Colour groups in English.

In table 5, we compare the colour groups of both source languages. Interestingly, Pink, Grey, Brown and Orange are more frequent in English originals, while Verde (Green), Preto (Black), Branco (White) and Amarelo (Yellow) are more common in Portuguese.

The morphological productivity of hyphens in English allows several multiple colours to be created, such as black-and-white, blue-green, or rose-red, which leads to a higher number of Multiple cases. On the other hand the use of the word cor (colour in Portuguese) without any further specification is undoubtedly more frequent in
Portuguese than in English. Another interesting observation is that the colour words belonging to the groups Dourado (Gold) and Prateado (Silver) are far more frequent in Portuguese than in English, given that the words gold and silver are often classified as cor_0 (vague between colour and not colour), due to their double sense. In fact, gold in gold letters or in gold taps may as well indicate something that has the colour of gold or which is made of gold itself.

We have also investigated morphological patterns such as unspecified, multiple, other, silver, gold, pink, grey, beige, brown, purple, green, orange, red, yellow, blue, black, white, brown, unspecified, multiple, other, silver, gold, pink, grey, beige, brown, purple, green, orange, red, yellow, blue, black, white.

Table 5: Distribution of colour groups in English and Portuguese source texts. f stands for the frequency for each one hundred thousand words

|EN (original) | f  | PT (original) | f  |
|-------------|----|---------------|----|
| White       | 266| 32.5          |    |
| Black       | 246| 30.1          |    |
| Blue        | 167| 20.4          |    |
| Yellow      | 96 | 11.7          |    |
| Red         | 240| 29.3          |    |
| Orange      | 22 | 2.7           |    |
| Green       | 129| 15.8          |    |
| Purple      | 40 | 4.9           |    |
| Brown       | 130| 15.9          |    |
| Beige       | 24 | 2.9           |    |
| Grey        | 112| 13.7          |    |
| Pink        | 98 | 12            |    |
| Gold        | 65 | 7.9           |    |
| Silver      | 23 | 2.8           |    |
| Other       | 23 | 2.8           |    |
| Multiple    | 47 | 5.7           |    |
| Unspecified | 143| 17.5          |    |

Table 6: Morphological patterns of colours.

We have also investigated morphological patterns such as hyphenated compounds and the expression cor de X (corresponding to the English X-coloured).

Table 7: kinds of hyphenated colour words in English

|Kind of word| Freq | Example|
|------------|------|--------|
|colour-[borrowed from something]| 85 | cherry-red|
|colour-[hue modifier]| 66 | deep-blue|
|colour-[applied to something]| 66 | green-shirted|
|colour-["colo(u)red"]| 61 | carrot-colored|
|colour-[colour]| 46 | pink-brown|
|colour-[hair-related]| 44 | red-haired|
|colour-[skin-related]| 20 | olive-skinned|
|colour-[eye-related]| 8 | gray-eyed|

Table 8: Grammatical category of colours.

|Colour Part-of-Speech| PT | EN |
|---------------------|----|----|
|Adjectives| 3,201 | 3,721 |
|Nouns| 1,326 | 932 |
|Proper Nouns| 106 | 40 |
|Verbs| 90 | 108 |
|Adverbs| 1 | 7 |

Table 9: Differences in colour distribution in COMPARA.

The main goal of the present paper is to investigate the way colour is translated, or not translated, into English and Portuguese.

We also did some morphosyntactic studies, for example investigating the percentages with which the colour adjective position is postposed, preposed or predicated in relation to the noun it modifies; the use of relative clauses modifying colour; and coordination in Portuguese (Inácio et al., 2008) and then also comparing with English (Silva et al., 2008). We established that in COMPARA the more common coordinated colour (groups) are Branco, Vermelho, Azul and Preto in Portuguese originals, while White, Pink, Red and Blue are most frequent in English originals.

Table 4: Distribution of colour groups in English and Portuguese.

Table 3: Hyphenated colour words in English.

Table 2: Colour distribution in COMPARA of each language.

Table 1: Frequency of colour words in each language.
groups. rise to the considerable mismatch between the two word cor:vinho therefore classified under are used specifically for hair/skin and wine, being thus classified under Portuguese (Negro and Branco and Verde and Branco, green respectively), because their translation will most probably be preto e branco and verde e branco. Other examples of group mismatch involving Multiple in English are cases such as: grey-green (cinzento-azul-verde), included in the group Cinzento in Portuguese or blue-green (azul-verde), included in the group Azul in Portuguese. In English, the colours on both sides of the hyphen have the same importance, being only apposed; while in the Portuguese counterpart, the first element of the colour is toned down by the second one, i.e., grey and blue are toned down by green.

Another interesting observation, already hinted above, is that Portuguese seems to have more dedicated lexically determined colour words than English. This applies especially within the Red group: the words ruivo and tinto are used specifically for hair/skin and wine, being therefore classified under cor:humana or cor:vinho, contrast with their English translation, the word red, applied to both hair/skin and wine, and gives rise to the considerable mismatch between the two groups.

Further observation of the mismatch cases led us to establish the following hypothesis: the two languages do not seem to agree on the border between Red and Purple. This may be due to the Portuguese word púrpura (included in group Vermelho) being a false friend of purple (included in the group Purple). To investigate more thoroughly the correspondences between the two languages is important to take into account the direction of translation. Tables 10 and 11 (which only take into consideration the original texts for both languages in the first two columns) show the differences in the directions English to Portuguese, and Portuguese to English, respectively. As it has already been noted in connection with table 9, we can see from tables 10 and 11, that the most frequent cause for differences in colour groups in the translation has to do with the groups Multiple and Other too. We are however able to detect other regularities by inspecting the corresponding concordances:

For example, although Portuguese is generally considered to be more verbose than English, we found several examples to the contrary. For instance, the word black in black coffee is elided in translation into Portuguese (café), since it is implicit or irrelevant.

Other examples which are illustrative of genuine specific differences between the languages are for example the translation of red in red meat rephrased by carne mal passada, designating the same phenomenon by colour or by degree of submission to a human (cooking) process.

Table 9: Comparison between colour groups: percentage of correspondences and differences

| PT         | EN         | P=E | P≠E | E≠P |
|------------|------------|-----|-----|-----|
| Branco (644)| White (633)| 86  | 14  | 12  |
| Preto (509)| Black (487)| 80  | 20  | 16  |
| Azul (321)| Blue (323)  | 93  | 7   | 7   |
| Amarelo (178)| Yellow (177)| 87  | 13  | 12  |
| Vermelho (427)| Red (436) | 84  | 16  | 17  |
| Laranja (33)| Orange (34) | 94  | 6   | 6   |
| Verde (271)| Green (265) | 86  | 14  | 12  |
| Roxo (70) | Purple (95) | 83  | 17  | 39  |
| Castanho (142) | Brown (189) | 88  | 12  | 34  |
| Creme (29) | Beige (33)  | 79  | 21  | 30  |
| Cinzento (126) | Grey (171) | 85  | 15  | 37  |
| Rosa (122) | Pink (126)  | 93  | 7   | 10  |
| Dourado (153) | Gold (145) | 56  | 44  | 41  |
| Prateado (34) | Silver (40) | 50  | 50  | 58  |
| Outras (123) | Other (41) | 17  | 83  | 49  |
| Múltipla (10) | Multiple (57) | 30  | 70  | 95  |
| Nãoespecificada (353) | Unspecified (363) | 81  | 19  | 21  |
| Total (3,545) | Total (3,614) |     |     |     |

Table 10: (Original) English colour groups translated into Portuguese: percentage of overlap

| EN         | PT          | E=P | Differences |
|------------|-------------|-----|-------------|
| White (266)| Branco (279)| 89  | 11 15       |
| Black (246)| Preto (246)| 77  | 23 23       |
| Blue (167) | Azul (169)  | 92  | 8  9        |
| Yellow (96)| Amarelo (94)| 88  | 13 11       |
| Red (240)  | Vermelho (241)| 81  | 19 20       |
| Orange (22)| Laranja (22)| 95  | 5  5        |
| Green (129)| Verde (132)| 86  | 14 16       |
| Purple (40)| Roxo (23)   | 35  | 65 39       |
| Brown (130)| Castanho (110)| 73  | 27 14       |
| Beige (24) | Creme (19)  | 71  | 29 11       |
| Grey (112) | Cinzento (87)| 70  | 30 10       |
| Pink (98)  | Rosa (93)   | 90  | 10 5        |
| Gold (65)  | Dourado (82)| 68  | 32 46       |
| Silver (23)| Prateado (13)| 35  | 65 38       |
| Other (23) | Outras (59) | 52  | 48 80       |
| Múltipla (47) | Múltipla (5)| 4   | 96 60       |
| Nãoespecificada (143) | Unspecified (156) | 81  | 19 26       |

Table 11: Total (1,871) Total (1,830)
gelocor de fumoweco (included in the group Outras). Their translation in COMPARA does not present any problems: they correspond to off-white, smoke-gray and yellow (included in the groups White, Grey and Yellow, respectively).

| PT | EN | P=E | P≠E | E≠P |
|----|----|-----|-----|-----|
| Branco (365) | White (367) | 87 | 13 | 13 |
| Preto (263) | Black (241) | 83 | 17 | 9 |
| Azul (152) | Blue (156) | 97 | 3 | 6 |
| Amarelo (84) | Yellow (81) | 86 | 14 | 11 |
| Vermelho (186) | Red (196) | 87 | 13 | 17 |
| Laranja (11) | Orange (11) | 91 | 9 | 9 |
| Verde (139) | Green (136) | 86 | 14 | 12 |
| Roxo (47) | Purple (55) | 94 | 6 | 20 |
| Castanho (32) | Brown (59) | 91 | 9 | 51 |
| Creme (10) | Beige (9) | 60 | 40 | 33 |
| Cinzento (39) | Grey (59) | 79 | 21 | 47 |
| Rosa (29) | Pink (28) | 93 | 7 | 4 |
| Dourado (71) | Gold (80) | 58 | 42 | 49 |
| Prateado (21) | Silver (17) | 43 | 57 | 47 |
| Outras (64) | Other (18) | 14 | 86 | 50 |
| Múltipla (5) | Multiple (10) | 20 | 80 | 90 |
| Nãoespecificada (197) | Unspecified (220) | 86 | 14 | 23 |
| Total (1,715) | Total (1,743) |  |  |  |

Table 11: Comparison between (original) Portuguese colour groups translated into English.

6. Concluding Remarks

We have just scratched the surface of an enormous wealth of information and source of hypothesis which the annotation of this field in the two languages provides us with, and this paper is offered more like an appetizer than as a report of a long and fruitful study.

On the one hand, we wanted to disseminate and announce this resource for the computational linguistics community, as well as documenting the process followed and the available functionalities.

Much more important than the actual studies we have managed to do and present here is the fact that all this information is publicly available and easy to get, so that anyone interested in other issues relative to colours in the two languages is able to query and get data relevant for their studies.

In fact, this whole process was a pilot for the service we are now offering any serious user of COMPARA: if they contribute with manual revision of a particular semantic category, we incorporate it and their revision in a next version of COMPARA.

We expect that researchers interested in other semantic fields (for example, affect, or time, or place, to name just a few) will provide us with their lexical core and help us with the human revision of the corresponding result, thus helping to build a richer and more varied semantic resource for the contrast of Portuguese and English.

We believe this is an important step towards cooperative annotation and creation of a maximally useful, available, and rich resource for the comparison of English and Portuguese. It will also allow for serious and total validation of corpus-based contrastive (or monolingual) studies as argued for in Santos & Øksefjell (1999).

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