

The Sapir-Whorf hypothesis in the domain of colors: evidence from healthy and aphasic speakers

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Abstract The domain of colors has often attracted attention of researchers looking for evidence for the Sapir-Whorf hypothesis, and influence of language on color perception has been confirmed in many studies. The present paper aims, on the one hand, at providing further evidence for the effect on a healthy sample, and, on the other, at extending research to an aphasic sample affected by color anomia, a disorder that has never been dealt in the literature about the topic. A test based on color similarity judgments was administered to both samples. Speakers were either native speakers of Italian or of German. The colors of the test belonged to the green and blue area of color space, and judgments on the green/blue boundary and on the light blue/dark blue boundary were analyzed. The former boundary exists in both languages, while the latter is only marked in Italian. Results provided supporting evidence for a Whorfian effect in the domain of colors. However, this does not contradict the theory about the existence of universal basic color terms. Furthermore, the need for a more qualitative – rather than quantitative – approach to data is stressed.

Keywords: Sapir-Whorf hypothesis, Whorfian effects, Linguistic relativity, Color, Cross-linguistic, Color anomia

0. Introduction

The two basic assumptions of the linguistic relativity hypothesis, also known as Sapir-Whorf hypothesis, were that language categories are largely arbitrary and that these may influence the way speakers perceive reality. Both these theses are to be found in the writings of Edward Sapir and Benjamin Lee Whorf (see, for example, SAPIR 1921: 99-115 and WHORF 1956: 213-214). Since the color continuum seems to be divided and encoded by languages in rather different ways, the domain of colors has offered a fertile ground for research on the linguistic relativity hypothesis. Therefore, when dealing with color names, the two key assumptions of this hypothesis were that, on the one hand, color terms are largely arbitrary; on the other, that color names affect the way speakers perceive reality (REGIER, KAY 2009).

Back in 1969, Brent Berlin and Paul Kay challenged the first assumption of the Sapir-Whorf hypothesis, claiming the existence of a universal set of eleven basic color terms, which was to become a key topic in later research in the domain of colors.

In the following years, some studies were published that provided evidence for Berlin and Kay's theory (e.g. DAVIES, CORBETT 1997; ÖZGEN, DAVIES 1998). Yet, in the same years, some researchers reacted against the universalistic theories, and found evidence for color terms influencing color judgments of speakers. They claimed that these findings were also against universal basic color terms (see DAVIDOFF *et al.* 1999; ROBERSON *et al.* 2000; DAVIDOFF 2001; ROBERSON *et al.* 2004-2005).

However, as Kay (2006) later pointed out, admitting that color terms may influence the way colors are perceived is indeed compatible with the existence of universal basic color terms. The so-called Whorfian effects will then take place within the universal constraints imposed by language. Interestingly, in other similar studies that were published later, the question about basic color terms is no longer mentioned. This might be due to a general acknowledgment of the fact that basic color terms and Whorfian effects should be dealt with separately.

Studies on the Sapir-Whorf hypothesis continued, and recent studies suggested that Whorfian effects mainly occur for colored targets seen in the right visual field, since these stimuli are processed in the left hemisphere, where the language area is located (see GILBERT *et al.* 2006, ZHOU *et al.* 2010). Other studies, instead, had a cross-linguistic approach. They compared the behavior of speakers of two languages with different color boundaries, proving that there was a difference in the way the two groups of speakers perceived the colors involved in the test (WITTHOFT *et al.* 2003, WINAWER *et al.* 2007, ROBERSON *et al.* 2008, ATHANASOPOULOS 2009, ATHANASOPOULOS *et al.* 2011). In addition, a recent ERP study showed that these Whorfian effects are unconscious and automatic (THIERRY *et al.* 2009).

Although many studies were published that supported the Sapir-Whorf hypothesis in the domain of colors, there is still some uncertainty whether results are indeed to be interpreted as evidence for the hypothesis. Therefore, the aim of the present study was to provide some new evidence for Whorfian effects brought about by color terms.

The current study consisted in two separate experiments. The first experiment involved a healthy sample and had the aim of replicating results from previous research, though comparing two languages that had never been confronted in the literature about the topic, i.e. Italian and German. The second experiment involved Italian and German aphasic patients with a specific disorder for color names called *color anomia*. Aphasia is an acquired impairment of language processing which follows from damage to the brain. The impairment may affect language production and comprehension, reading, and writing. Patients with color anomia had never been involved before in similar studies. The goal of the second experiment was to provide evidence for language effects in the domain of colors testing people whose access to color names was disrupted.

Results from both experiments suggested that color terms influence color perception of speakers, thus providing more evidence for the linguistic relativity theory in the domain of colors.

1. Aims of the present study

Aim of the research was studying whether and how the specific native language (in this case, Italian and German) of speakers would influence their judgments on color boundaries.

The study focused on two color boundaries. First, the boundary between light and dark blue, which is marked in Italian, respectively with the terms *azzurro* and *blu*, but not in German. Some evidence has been brought up according to which *azzurro* is a twelfth basic color term in Italian (see PAGGETTI, MENEGAZ 2010). Yet, the possible ‘basicness’ of the term *azzurro* was not relevant in the present study.

Then, judgments on the blue/green boundary were taken into account, in order to assess whether Italian and German speakers here behave in similar ways, since this boundary exists in both languages.

2. Experiment 1: healthy speakers

2.1. Methods

2.1.1. Participants

Twenty participants per language took part in the study. For each group of speakers, there were ten males and ten females. Mean age was 27.45 for the German sample and 27.50 for the Italian sample. As for education, most speakers of both samples had a high school diploma (11/20 in both cases) or a bachelor degree (5/20 of the German and 4/20 of the Italian speakers). Most of them were students (14/20 Germans, 12/20 Italians). They all reported to have normal or corrected-to-normal vision.

2.1.2. Materials

All groups of speakers were administered a test consisting in similarity judgments between pairs of colored squares. The test included thirteen pairs of colors, repeated twice in a random order, so as to avoid influence from the order in which they occurred (total number of pairs = 26, labeled with letters from A to Z). Colors belonged to the green and blue area of color space and were shown on a neutral light-gray background. Pairs were either composed of two colors belonging to the same category in both languages (both dark blue, or both light blue, or both green), or to different categories for both languages (blue and green), or rather to different categories only for Italian speakers (dark blue and light blue).

Colors were formed using the RGB color system, and pairs were created following specific criteria, so that results of the judgments could be objectively discussed.

In particular, pairs deserving particular attention in the discussion of results were:

- Four pairs composed of a light and a dark blue (pairs A, C, G, L, repeated as Q, N, T, Z).
- Two pairs composed of a green and a blue (pairs B, D, repeated as V, W). In both of them, the distance between the green and the blue was objectively identical to that between, respectively, two blues and two greens appearing in two other pairs (pairs M, K, repeated as X, P). Judgments on these pairs were then confronted.

2.1.3. Procedure

For each pair, speakers were asked to judge the similarity of the two colors, using a 5-point likert scale (where 1 was the highest degree of similarity and 5 the lowest).

Before the performance of the test, speakers were warned that colors were only green and blue hues, and that they should try to use the whole 5-point scale when judging similarities. During the test, they could not go back to see previous colors.

The test was shown on a computer screen, with daylight, in an indoor setting. Speakers were seated and the screen always had the same inclination. Participants reported their judgments onto a response sheet.

Speakers could take as much time as they needed to make their similarity judgments. For healthy speakers, the test never lasted longer than ten minutes.

2.2. Expectations

Participants were expected to judge color pairs basing their judgments on the category to which colors belonged.

As for pairs testing the light blue/dark blue boundary, Italian speakers were expected to judge the elements of the pairs as less similar than German speakers.

On the blue/green boundary, elements of the pairs whose colors belonged to two different color categories were expected to be judged by speakers of both languages as less similar than elements of the pairs whose elements had the same name.

2.3. Results

Tab.1 shows the mode of judgments on pairs testing perception of speakers of the green/blue boundary. Judgments on pairs presenting a green and a blue ('cross-category' pairs) were higher than those on the corresponding pairs presenting two blues or two greens ('within-category' pairs) in two cases out of four for the German sample and in all cases for the Italian sample. Note that the mode is reported because mean results cannot be used when dealing with likert scales.

German				
cross-category	B 4	D 2-3	V 3	W 4
within-category	M 3	K 4	X 4	P 3
Italian				
cross-category	B 5	D 5	V 5	W 5
within-category	M 4	K 2	X 2	P 4

Tab.1 – Modes of judgments by the German and Italian sample on cross-category and within category pairs on the green/blue boundary.

In order to prove statistical significance of results, an independent-samples Mann-Whitney U Test was performed, crossing the dependent factor 'Ratings' with the two groups 'Pair Type' (fixed factors). The test showed a significant relationship between Ratings and Pair Type ($U=7,532.5$, $p<0.001$). This suggested a statistically significant interaction between judgments and the membership of the two colors of the pairs to the same or to a different category, independently from the speakers' native language, which was consistent with the fact that the blue/green boundary exists in both languages.

Tab.2 shows the modes of the judgments by Italian and German speakers on the pairs composed of a light blue and a dark blue. Judgments by Italian speakers were higher than those by German speakers in four cases out of eight, and they were never lower.

	A	C	G	L	N	Q	T	Z
Italian	3	5	3	3	4	2	3-4	3
German	3	4	3	2	4	2	3	2

Tab.2 – Modes of judgments by the German and Italian sample only on cross-category pairs on the light blue/dark blue boundary.

In order to prove statistical significance of the results emerging from these pairs, an independent-samples Mann-Whitney U Test was performed, crossing the dependent factor ‘Ratings’ with the two groups ‘Language’ (fixed factors), since the difference in the native language of speakers, here, was expected to play a role. The analysis proved, again, statistical significance of results ($U=10,296.5$, $p<0.05$).

2.4. Discussion

Data on judgments by healthy speakers confirmed expectations, and therefore the existence of a language effect in the performance of the task. Statistical analysis showed that judgments were influenced by whether colors of the pairs belonged to the same color category in the native language of speakers.

3. Experiment 2: aphasic speakers

Speakers with color anomia were observed performing the same task, in order to gain an insight on how their disorder interfered with their perception of color boundaries. Aphasia represents a fertile ground for observations in the domain of Whorfian effects, since the disruption of access to language skills may help understand how perception actually works without language interference.

Generally, one speaks of ‘color anomia’ for a purely linguistic problem: patients with this disorder often make mistakes when naming colors or when they are asked to point to a named color. However, they have normal color vision and are able to match colors correctly (OXBURY *et al.* 1969). The disorder is prototypically associated with right homonymous hemianopsia (decreased vision or blindness in the right half of the visual field of both eyes) and with pure alexia (inability to read, with largely spared writing) (STACHOWIAK, POECK, 1976). Geschwind and Fusillo (1966) hypothesized that its origin is a lesion in the posterior part of the *corpus callosum*, which is assumed to connect the right visual area with language regions in the left hemisphere. Hence, both the language areas in the left hemisphere and the right visual cortex are intact, but language areas cannot receive adequate information from the visual data (FUKUZAWA *et al.* 1988). Today, the disconnection hypothesis is often considered reasonable, but not necessarily valid for all the cases. Certainly, color anomia has a manifold nature. Every patient represents a unique case, with specific lesions and consequences, but also a specific reaction to the disorder and a specific history. Hence, the need of giving space to all the patients in separate paragraphs.

Finally, when analyzing data from patients, we decided to apply a more qualitative, descriptive analysis due to the small number of patients and their diverse responses and behaviors during the test.

3.1. Methods

3.1.1. Participants

Four German patients and one Italian patient took part in the experiment. German patients were all tested in March, 2013 in cooperation with the University Hospital in Freiburg im Breisgau (Germany). They will be referred to as GP1, GP1, GP3, and GP4. The Italian patient was tested in August, 2013 in cooperation with the CeRiN (Centro di Riabilitazione Neurocognitiva) in Rovereto (Italy). The case will be referred to as IP1. Cases will be illustrated separately, followed by a common discussion of results.

3.1.2. Materials

The materials used for the test were the same as those used with the healthy sample (see §3.1.2.)

3.1.3. Procedure

The procedure of the test corresponded to that used with the healthy sample (see §3.1.3.). However, aphasic speakers were asked to say the number corresponding to their judgment, and their answers were reported onto the response sheet by the instructor. This just aimed at making the task easier for them, since they all had some difficulty in carrying it out. Aphasic speakers needed approximately fifteen to twenty minutes to complete the test.

3.2. Expectations

Expectations on the aphasic sample were strictly connected to the features of their disorder. All the patients seemed to have the most prototypical variety of color anomia. Thus, their color perception and their color language function were intact, but the visual stimuli could not reach and activate lexical entries.

Expectations on patients can be summarized as follows:

1. If color entries could not be accessed, then patients would perform the task on a purely perceptual basis, which meant that language would have no influence on their performance and judgments would be consistent with objective color differences.
2. If language entries could somehow be accessed, then patients would perform the task in a similar way as healthy speakers. Thus, all the expectations mentioned for healthy speakers would also be valid for aphasic speakers.

Color language was always activated before patients carried out the task, by asking them to name specific colors (which were then named by the instructor, in case patients said the false name). Therefore, patients probably had at least a temporary access to color lexicon and, in this case, the second hypothesis should be confirmed. However, it must also be considered that color lexicon often remains active for a short time and, therefore, patients might lose access to it. In this case, the first hypothesis should prevail.

In the case of German patients, their judgments on the blue/green boundary were taken into account, while, in the case of the Italian patient, both judgments on the blue/green and on the light blue/dark blue boundary were considered.

3.2. Results

3.2.1. German Patient 1

GP1 is a male and was 62 years old at the time of testing. He used to be a technician. 24 months before testing, he had an ischemic stroke in the posterior cerebral artery. He suffers from pure alexia, right homonymous hemianopsia, and color anomia.

A color naming test performed several days prior testing revealed medium difficulty (7 correct answers out of 9 colors, with many hesitations and some self-corrections).

GP1 exhibited accurate perception and a fine ability to distinguish colors. This was shown in his judgments on the two pairs of the test with identical colors, which he judged as a '1', and in the pairs with very similar colors, which he judged as a '2'.

The patient had a clear strategy for the performance of the task, basing his judgments on the color categories to which the colored squares belonged. Hence, when judging a pair composed of a dark blue and a very light blue, he claimed the two colors to be very different, but rated their difference as a '4', since, he said, they were two blues. Instead, in another occasion, he observed that one color was green and the other was blue, and that therefore his answer was '5' (although, in fact, the two colors were not very different). In the second repetition of the test, he gave consistent answers to what he had previously stated.

GP1 had great difficulty in performing the task, especially in transforming his judgments into a number. This is probably why he relied on a specific – linguistic – strategy.

From the observations made during the performance of the test, it can be concluded that color terms were sometimes clearly accessible and that some judgments strongly based on a language strategy. However, the later analysis of his judgments on pairs concerning the blue/green boundary showed no language effect.

3.2.2. German Patient 2

GP2 is a male and he was 76 at the time of testing. He used to be a high-school teacher. 16 months before testing, he had an ischemic stroke in the posterior cerebral artery. He suffers from pure alexia, right homonymous hemianopsia, and color anomia.

A color naming test performed several days prior testing revealed a severe impairment (4 correct answers out of 9 colors, with many hesitations).

On the day of the test, before and after its performance, language names were tested. GP2 showed again serious problems in recollecting names of even every-day objects, although he claimed he could mentally visualize objects with their right colors. Naming was not only impaired for visual stimuli, but also for verbally mentioned objects, which suggests that his disorder was not only restricted to the visual modality.

Perception, on the contrary, was intact, even for very fine distinctions. This also emerged from GP2's judgments on identical and very similar pairs in the test.

Once a color category had been activated by the instructor, the patient was able to repeat it and he often kept on repeating the same name when he was asked to name the color of other objects. Furthermore, he often named the color 'green'.

Results from the test showed no language effect on the blue/green boundary: the elements of the color pairs were judged on their perceptual difference and in a consistent way, with no apparent influence from color names.

After the test, naming of colors that form lexical collocations was tested. The patient had fewer problems with such colors: he was able to name the color of blood (red), and the color of the sky (blue). The latter case is very interesting, since the sky is not properly 'blue', and may testify a certain language effect. On the other hand, when colors were not lexicalized in German, GP2, as mentioned above, had difficulty in recollecting their names. An interesting case was the color of chocolate: the patient argued that there was also a 'yellow' chocolate, but that this was not its prototypical color. This is interesting, since this kind of chocolate is called 'white' in German (*weiße Schokolade*), despite actually being (light) yellow rather than white. Hence, in the absence of language activation, the patient was able to say the actual color of 'white chocolate'. The patient was then asked if he could see something in the room that had the same color as the 'prototypical' chocolate. Since he could not answer, we claimed that there was a bag in the room with the same color of chocolate. The bag was actually a lighter brown than the 'prototypical chocolate'. The patient replied that this was not really the color of chocolate. Again, this may show that, since the particular language category 'brown' was not accessible for the patient in that particular moment, he was able to judge colors more objectively than healthy people, who would not have hesitated in claiming the bag to have the same color as chocolate (since they were both 'brown'). After the patient's assertion, we underlined that indeed, both chocolate and the bag were 'brown', and so they had the same color. In that moment, the patient changed his mind and agreed with us. Hence, when the color 'brown' was pronounced, the color category was accessible, and a language effect seemed to start. Furthermore, right after this, GP2 was asked to name the color of the middle light of a traffic light. Looking at the bag, he said it was brown. For this answer, there may be two possible interpretations: I. the patient, as he had previously done, just said the name he had access to in that moment; II. the patient compared the mental color he had of the light with the color of the bag and, since they looked somehow similar, he decided that the word 'brown' could also apply for the middle light of the traffic light. Since he actually looked at the bag before answering, the second option might be reasonable.

From all the data and observations, it can be concluded that, while performing the task, GP2 had no influence from language. When color categories were active, however, he showed a language effect on the naming and identification of colors. Language was also still present in lexical collocations.

3.2.3. German Patient 3

GP3 is a female. She was 51 at the time of testing, but no further biographic data were available. In April and May 2012 she had ischemic infarctions in the left posterior cerebral artery. Initially, she had complete alexia, including single letters. Today, her alexia is still very severe.

There was no occasion to test her color naming skills some days before the test. Therefore, color naming was tested on the same day of the examination, as a first step. When she was asked to identify which of four identical images had the right color, she always gave the correct answer, despite being sometimes unable to name colors. She had particular troubles with more difficult colors, such as violet, and with mottled surfaces. In this latter case, she seemed confused by the various colors composing the surface. For example, when she had to name the color of her table cover, which was a mottled light yellow surface with some white veins, her answer was 'white', which did not correspond to what healthy speakers would have

answered, but was, in fact, close to reality. The same happened with other very light hues.

The behavior of GP3 with light hues could be explained by two hypothesis: I. she also suffered from a mild color agnosia, i.e. she was unable to distinguish between color patches; II. her categorization of light hues was independent from language, therefore she categorized all light hues into 'white', since they were perceptually similar to this category. The second hypothesis might be reasonably accepted. However, it must also be considered that she once named 'white' the dark and the light blue forming one pair of the test.

Her pure alexia was very severe and she had serious problems even in reading single letters. When she was asked to read letters, she tended to say often 'S'. A similar tendency to perseverate was not observed in color naming.

While performing the task, she found it difficult to translate her similarity perception into a numerical judgment. For the first repetition of the trials, there seemed to be a language effect. However, this completely disappeared in the second repetition.

3.2.4. German Patient 4

GP4 is a male and he was 69 at the time of testing. 51 months before the test, he had an intracerebral hemorrhage, primarily affecting the posterior brain. He suffers from pure alexia, color anomia, and right homonymous scotoma, i.e. a partial blindness in the right visual field.

A color naming test performed several days before examination revealed mild impairment (6 correct answers out of 9 colors, with some hesitations). There was no significant observation on the patient, a part from his difficulties in naming violet and orange, both in prior testing and in testing after the color similarity task. This difficulty may be explained by the fact that their perception is more complex than that of the four 'primary hues' (HERING 1920: 40-48). It could also relate to the lower frequency of these color names or their lower familiarity.

From GP4's judgments on color pairs, there emerged no particular language effect.

3.2.5. Italian Patient 1

IP1 is a male and he was 65 at the time of testing. He is a technician but had to reduce his activity due to his neurological problems. His lesions were probably caused by an ischemic stroke of the posterior brain due to a vertebral dissection, at the beginning of 2009. Today, the patient has a mild color anomia and right homonymous hemianopsia. The severity of his pure alexia diminished along the years.

Color naming ability was tested on the same day of the test. The disorder was confirmed to be mild. Some difficulty was encountered by IP1 in the naming of mottled colors, such as the color of the floor and of the surface of the table in the testing room. Interestingly, the patient, in these cases, tended not to give a definite answer but rather to list the different colors that made up the surface. Hence, in the presence of a mottled dark yellow floor, he claimed it to be composed of yellow, white, and brown, and, in the case of a mottled brown table, he claimed it to contain both brown and black veins. As in the case of GP3, the patient's observations would have not been made by a healthy speaker, who would have probably just answered, respectively, 'yellow' and 'brown' without much hesitation. Therefore: was this a consequence of a certain freedom of the patient from linguistic constraints, which made him see reality in a more objective way? Again, this might be a reasonable hypothesis.

IP1 found the performance of the task particularly difficult, especially translating his judgments into numbers. During the test, he sometimes relied on language categories to judge similarity of the pairs. Sometimes, color terms were accessible and he explicitly mentioned colors. In one case, for example, he correctly claimed the two colors to be *azzurro* and *blu*, and therefore judged the similarity between the two as a '4'. In the case of another pair with a light and a dark blue that were further apart than those of the previous case, he did not mention the term *azzurro* and just claimed the two colors to belong both to the 'blue gradation', and therefore his judgment was '2'. Once, he claimed one of the colors to be *azzurro* instead of green, probably because he had been naming the former color many times. Interestingly, he expressed the same judgment on the same pair in the second repetition, but this time correctly naming the color 'green'. In both cases, his judgment was '5', although he even emphasized that the two colors were similar. This suggests that his difficulty with the 5-point scale partially distorted results.

Fine perception was shown by IP1 both before and during the performance of the test, as demonstrated by his judgments on pairs with identical elements.

On the green/blue boundary, his judgments did not suggest any language effect. On the light blue/dark blue boundary, answers were not consistent either with objective differences of the color or with language categorization. Data on the judgments by the patient, therefore, do not seem in either case to be relevant for the present research, mainly because of their lack of consistency.

3.3. Discussion

As it has been emphasized above, for the aphasic sample, a descriptive approach was preferred, rather than a statistical analysis of data, given the size of the sample and the diversity of behaviors.

Findings on this group of speakers emerging from the performance of the similarity task can be summarized as follows:

1. Patients often did not judge pairs consistently. This seemed to be due to their difficulty in performing the test.
2. When color entries could be accessed in the lexicon, patients tended to rely on them to perform the task. They often named colors to decide how to judge the pairs.
3. When color entries could not be accessed in the lexicon, patients seemed to judge color pairs more consistently with the objective appearance of colors.

As for other naming tests conducted before and after the similarity task, the following conclusions were drawn:

1. When patients had no access to color names, they seemed to perceive colors only through their actual appearance. This made them judge the colors of objects differently from expected by the experimenters. They were sometimes able to describe reality in a more realistic way than healthy speakers would have done, and it was hypothesized that this was due to their freedom from language constraints.
2. When the lexical entries of color names were available, patients then started to agree with the experimenters on color names and descriptions. This was mainly witnessed with GP2.

To conclude, expectations on the sample were met, and language effects could be observed, yet only by means of a qualitative, descriptive approach.

4. General discussion

A comparison between the healthy and the aphasic sample is not possible for some reasons:

1. The size of the groups were very different from each other.
2. The mean age of healthy speakers was significantly lower than that of aphasic speakers.
3. The approach used to analyze data from healthy speakers diverged from that used with data from patients.
4. Judgments by aphasic speakers were often inconsistent, and their behavior during the task was much more revealing than judgments themselves.
5. Patients often found the task difficult.

Evidence for Whorfian effects was found in both experiments. The membership of color hues to specific color categories in the native language of speakers proved to be a relevant factor influencing judgments for both the Italian and German sample of both experiments.

Therefore, results and observations bring some evidence for the Sapir-Whorf Hypothesis in the domain of colors. Language here emerges as a powerful factor influencing performance of speakers – who sometimes even intentionally relied on it. However, this must not be intended either as supporting evidence for a strong interpretation of the hypothesis, or as a claim against universal color terms. As suggested by Wolff and Holmes (2011), the findings of the two experiments might be interpreted as a case of ‘language as meddler’: «linguistic codes, in effect, meddle with nonlinguistic codes in the process of making a decision» (2011: 256) and this happens, according to the authors, when thinking occurs simultaneously with speaking. The phenomenon might also be categorized as ‘Ontological Whorfianism’ (REINES, PRINZ 2009), meaning that language may lead speakers to categorize the world in a different way than they would have done without language. This distinguishes Ontological Whorfianism from ‘Radical Whorfianism’, which must be rejected because it implies that categorization is not possible without language.

5. Conclusions

In conclusion, expectations about the two experiments were confirmed. Data from the experiment with the healthy sample and observations from the experiment with the aphasic sample confirmed that color terms influenced the behavior of speakers. It can be concluded that the present study provides further evidence for the occurrence of Whorfian effects in the domain of colors and represents a contribution to the state of the arts about the topic.

However, some work still needs to be done, and some questions are left open.

First of all, the aphasic sample was relatively small, since finding patients affected by color anomia was very complex, due to the rarity of the disease. A longer time-span would probably be needed in order to find more patients and extend results of the research.

Clearly, the same holds true for the healthy sample, which could also be enlarged in order for results to be more relevant. Healthy speakers may also be selected to match for age with aphasic speakers, in order to allow a comparison between the two samples.

Different kinds of tasks may also be administered to the samples. Oddball tasks may, for example, serve the purposes of the study, as well as other similarity judgments,

possibly not based on numerical scales, so as to avoid the difficulty encountered by patients.

Furthermore, some considerations are needed about the conclusions drawn from results: is it really language at the origin of results? Although patients sometimes explicitly relied on color names to perform the task, it remains unclear whether the key-point was color names, or rather just mental color categories not involving language. It would be interesting to teach participants new color categories without assigning a name to them, and make them perform a similar task on the newly learned boundaries between colors (a relevant study with newly learned color names was published by Özgen and Davies in 2002 and Zhou *et al.* 2010).

Once again, the need for a more qualitative approach needs to be stressed. This not only did produce much more relevant observations on the aphasic sample than just a plain analysis of the means of their judgments, but also seems to be more faithful to the nature of research with patients. Patients with color anomia differ from each other under many aspects, among which the severity of their disorder and the other impairments occurring with color anomia. Moreover, education, previous working situation, and other social factors may play a more relevant role in the case of patients than in the case of healthy speakers.

A final remark concerns the fruitful resources that the domain of neurology offers in the validation, or at least further development and analysis, of linguistic theories: studies on language are interdisciplinary in their nature, and the time should be now ripe for a larger cooperation between different disciplines.

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