

Neurocase: The Neural Basis of Cognition

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/nncs20>

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Published online: 16 Feb 2007.

To cite this article: R. Pita , E. Aretouli , E. Loukopoulos , D. Parisis , P. Ioannides & D. Karakostas (2005) Can 'Football-Team Color-Code' Compensate for Anomia? The case study of FN, a patient with color anomia, *Neurocase: The Neural Basis of Cognition*, 11:3, 227-233, DOI: [10.1080/13554790590944870](https://doi.org/10.1080/13554790590944870)

To link to this article: <http://dx.doi.org/10.1080/13554790590944870>

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Can ‘Football-Team Color-Code’ Compensate for Anomia? The case study of FN, a patient with color anomia

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A case study is reported on large ischemic infarcts involving cortical and subcortical areas of the parietal lobes bilaterally, especially left temporo-parietal and right parietal. On examination, the diagnosis of vascular dementia with color anomia, optic aphasia for colors, was established. The patient (FN) showed great difficulty in understanding a scene as a whole and in describing complex scenes. FN's oral comprehension skills at word and sentence level were satisfactory and he exhibited communicative effectiveness during conversation. He could read letter by letter, but could not make simple judgments of shapes. FN exhibited a marked inability to name colors presented to him visually and to indicate or point to the color requested from the examiner. The most interesting of all the patient's characteristics was the strategy – a football-team color-code – he had developed for compensating for his inability to name colors.

Introduction

The present study deals with a rather unique case study of color anomia. Although case studies are unique by their very nature, what we aim to highlight is the rather unusual case of a patient who has resorted to using the colors of football team apparel (color of T-shirts and short pants) to substitute for the original names of colors he cannot pronounce under any circumstance.

Mapelli and Behrmann (1997) indicated that color information may not be useful for the recognition of all objects, but may play a valuable role under a restricted set of circumstances for color naming tasks. Price and Humphreys (1989) have shown that surface dimensions may become more informative when objects from structurally similar categories need to be disambiguated.

When objects are presented clearly and unmasked, a color advantage has been observed (Ostergaard and Davidoff, 1985; Davidoff and Ostergaard, 1988; Brodie *et al.*, 1991; Wurm *et al.*, 1993). Furthermore, Price and Humphreys (1989) showed that both object naming and superordinate classification were facilitated by congruent surface color and inhibited for incongruent color. The influence of color was particularly noticeable for objects of structurally similar classes, for which fine discriminations were necessary to differentiate important details.

Regarding the object-color knowledge, the extent to which an object is associated with a color is referred to as diagnosticity

(Mapelli and Behrmann, 1997). Diagnosticity, or the extent of the association between an object and its color, is not simply a perceptual effect. While the presence of color in a display may cue the viewer to a particular object in a bottom-up fashion, long-term knowledge might also contribute (Jackendoff, 2003).

How could this be helpful in the case of color anomia (the inability to name colors of common objects), where a patient loses the ability to associate words to the concepts they stand for? Could a football team have high color diagnosticity? In the psychological sense, sports spectators seek, through a process of identification, a refuge from anonymity (Crystal, 1997). The color of the team or the city of its origin can then become the symbol of the victory: “Yellow God from Thessaloniki” is what its fans call a Greek football team who has fulfilled their expectations (a team which originates from the city of Thessaloniki and whose distinctive color is yellow). Thus football fans often develop a local as well as a color communication code. Could this color communication code compensate for anomia deficits?

Damasio and Damasio (1992) described cases of color anomia, in which patients retained normal color experience (e.g., they could sort colored chips into groups correctly), whereas they had no trouble producing color words, but they were unable to name colors appropriately: they used the word ‘blue’ or ‘red’ showing green or yellow. The patient’s mastery of the phonological aspect seemed quite intact; thus, their mastery of the concepts of, for example, blue and red also appeared to be intact. The phonological and visual pairing seemed to be disturbed (see Caplan *et al.*, 1996; Jackendoff, 2003).

Davidoff (1999) commenting on Lewandowsky’s patient (1908) as a profound case of color anomia, summarized the few cases of color anomia that could show intact retrieval of

Received 18 June 2004, accepted 12 October 2004.

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object-color knowledge, differentiating from visually presented achromatic drawings of objects (see Geschwind and Fusillo, 1966; Beauvois and Saillant, 1985; Larrabee *et al.*, 1985; Fukuzawa *et al.*, 1988; Coslett and Saffran, 1989). He continued (1999:148), mentioning that the reverse dissociation of good color naming and poor object-color retrieval is limited to two or three cases, those of Farah *et al.* (1998), Schnider *et al.* (1992) and the case of Engerth, reported by the previous authors.

In our study we are focusing only on the visual-verbal disconnection and specifically in color anomia, distinguishing from pure alexia (alexia without agraphia) and object anomia (optic aphasia) (Benson and Greenberg, 1969; Girkin and Miller, 2001). Patients with color anomia can match colors: they don't have achromatopsia or an agnostic deficit. Their semantic recall of color is intact and they are, thus, able to recall accurately the color of known objects (i.e., the color of a banana or an apple). Anomia is not restricted to color nouns. Indeed, as one goes on rostrally along the temporal lobe, areas which mediate form-meaning pairings of other nouns are encountered and are often topographically organized in surprising ways (Ojemann, 1983; Semenza and Zettin, 1989; Brown and Hagoort, 2003). Damasio and Damasio (1992) called such areas 'convergence zones', emphasizing their role not in representing anything per se, but rather in organizing and linking in a flexible manner other areas, which store information or for example, pattern recognition.

There have been reports (Miceli *et al.*, 2001) of two brain-damaged subjects who exhibit the uncommon pattern of loss of object color knowledge, but spared color perception and naming. The subject PCO was also impaired in processing other perceptual and functional properties of objects. In contrast, subject IOC was the first subject on record to have impaired object color knowledge, but spared knowledge of object form, size and function. Here it should be mentioned that data from PET studies indicate that distinct neural structures are active in perceiving color and retrieving object color knowledge, demonstrating that perception, recognition and naming of color are distinct from access to object color knowledge (Marr, 1980, 1982; Carlesimo and Caltagirone, 1995; Miceli *et al.*, 2001).

Furthermore, Roberson *et al.* (1999) reported the case of LEW, who showed that his similarity judgments for colors could be based on perceptual or categorical similarity according to task demands. Also, LEW's inability to make explicit use of his intact (implicit) knowledge was assessed as related to his language impairment.

In this publication, we report the case of a male patient suffering from color anomia and optic aphasia, due to many strokes bilateral to the posterior parietal lobes and due to left temporal-parietal atrophy. The striking feature of our patient's performance was the strategy he had developed in order to compensate for his color-naming inability, using the names of the football teams instead of the names of colors in order to name the color requested, as explained later.

Case Report

Neurological examination

A 57 year-old-right-handed Greek male (FN) was admitted to the Emergency Department of AHEPA Hospital (Department of Neurology of the Aristotle University of Thessaloniki) because of acute difficulty in walking. The patient scored 15 on the Glasgow Coma Scale. The initial neurological examination revealed a severe left hemi paresis, mainly involving the leg. The evaluation of the sensory and cerebral function was less clear, because the patient could not cooperate well during the examination. According to the consulting neurologist, the patient's behavior demonstrated a mild deficit in attention, as well as moderate components of apraxia and agnosia. Therefore, a detailed neuropsychological assessment was required. The medical history of the patient included heart failure (probably due to dilated cardiomyopathy) and an undefined old cerebral-vascular event. The patient had also been a heavy smoker. Physical examination revealed tachypnea, signs of arterial atherosclerotic disease and a mild systolic murmur, most prominent at the apex of the heart. Blood, chemical and enzyme levels were normal. The chest roentgenogram demonstrated left ventricular enlargement.

Finally his CT, obtained the following day, showed large ischemic infarcts involving cortical and subcortical areas of the parietal lobes bilaterally, especially left temporo-parietal and right parietal (see Figure 1 a, b). On examination the diagnosis of vascular dementia with color anomia and optic aphasia for colors was established.

Neuropsychological assessment

FN had a low educational level (6 years of education), and was formerly a worker in the water-drilling business. It is of great importance to mention that he was an avid football fan. He was single and lived alone prior to his admission in the hospital. Before testing took place there was a report from the nursing, as well as from the medical staff, that FN was color deficient and was unable to name colors. The patient was evaluated twice, on the 15th and the 17th April 2004.

Part A- screening

The neuropsychological examination involved the following tests and questionnaires: the standardized Greek version of Mini Mental State Examination (Folstein *et al.*, 1975), and the Greek version of the BURNS Brief Inventory of Communication and Cognition (Left Hemisphere Inventory, Right Hemisphere Inventory and Complex Neuropathology Inventory) (Burns, 1997). During the neuropsychological assessment the patient was tested in several higher-level cognitive tasks. Tables 1 and 2 illustrate his scoring in the above-mentioned tests. He was first administered the Mini Mental State Examination, in which he displayed particularly poor performance (< 13). Except for the month, FN was not able to orientate in

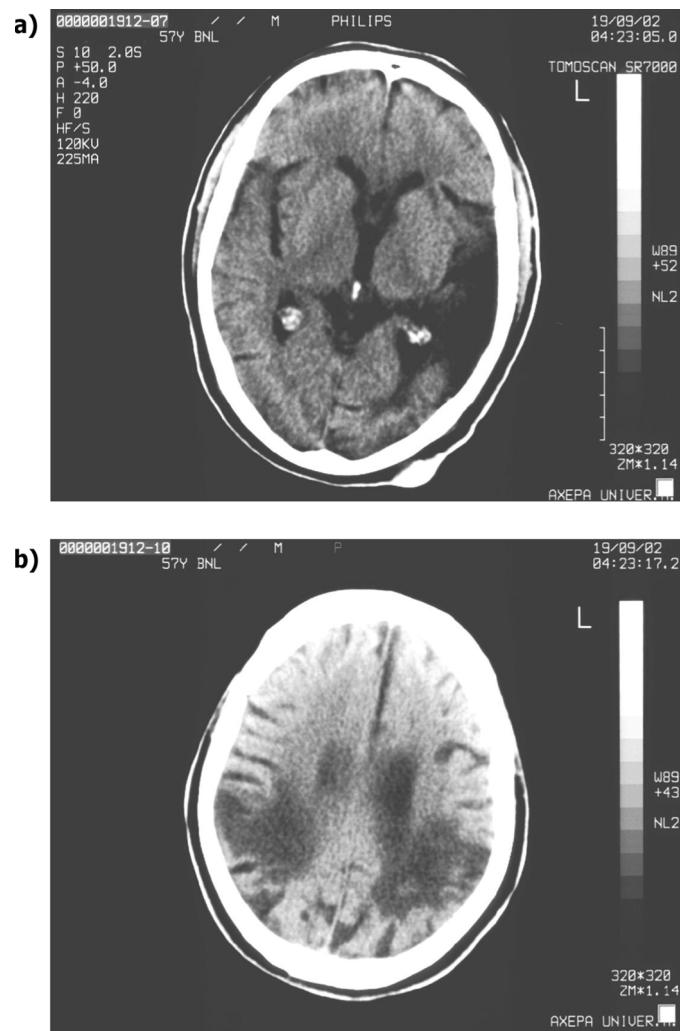


Fig. 1. The CT of FN showed large ischemic infarcts involving cortical and subcortical areas of the parietal lobes bilaterally, especially left temporo-parietal and right parietal.

time, although he seemed to have intact spatial orientation. He could recall the name of the hospital and the city (Thessaloniki), but when asked in which country he was, he answered, "I don't understand what we are talking about" (Greek correct form: "Δεν καταλαβαίνω για τι πρόγμα μιλάμε"). He was also able to repeat words, as was instructed, but was unable to remember these same words, after an intervening task. FN showed spared ability to name objects presented to him visually.

In particular, as far as his ability to comprehend was concerned, FN showed spared comprehension of simple sentences and instructions and exhibited problems in comprehending oral speech in particularly complex sentences and instructions. His speech was preserved at a satisfactory level, but his reading was defective. He produced letter-by-letter reading, but reading words was performed only slowly and with difficulty. Sentence reading was impossible. Likewise, the patient was also unable to write or successfully draw anything that

Table 1. Scoring of FN in BURNS Brief Inventory of Communication and Cognition

Left hemisphere inventory:

Description of a picture	only qualitative data
Comprehension of simple words and sentences	10/10
Oral reading of words and sentences	7/10
Reading comprehension of words and sentences	8/10
Automatic speech	5/10
Confrontation naming (nouns)	10/10
Money	5/10
Writing to dictation	0/10
Functional writing	0/10
Complex neuropathology inventory:	
Immediate auditory recall of digits	2 / 10
Color recognition	0/10
Word matching	5/10
Functional short-term recognition	2/10
Short-term recognition of words	4/10
Short-term recognition of pictures	6/10
Delayed recognition of words	2/10
Delayed recognition of Pictures	8/10
Right hemisphere inventory:	
Functional scanning and tracking	2/10
Scanning and tracking of single words	4/10
Spatial distribution of attention	5/10
Recognition of familiar faces	2/10
Gestalt perception	2/10
Receptive Prosody	6/10
Inferences	4/10
Metaphorical language	3/10

Table 2. Neuropsychological data

Mini Mental State Examination	>13
Digit Span Forward	3 digits
Token Test	administration was interrupted
Word-picture matching (nouns)	7/8
Word-picture matching (verbs) or action matching	2/8
Abstract Thinking with visual stimuli	1/6
BORB-Short Version	10/15
BORB-Long Version	57/76
Boston Naming Test1	22/180

he was instructed to (i.e., drawing a clock) and showed great difficulty in making simple calculations (see Table 1).

The patient had also spared knowledge of object colors, as was demonstrated by his answers on questions such as "what is the color of salt", "what is the color of an apple" and so on, in which he answered correctly, though always using his football-team-color-code (BURNS, see Table 1).

Here it should be noted, that, interviewing the patient's social circle as well as the patient himself, it was confirmed that FN neither used this 'color-code' before the infarction, nor showed any weakness of color recognition before the lesion.

In order to test his perceptual (as well as his picture naming) ability the patient was asked to describe a complex picture. He seemed to have impaired perception ability, as he was unable to notice crucial details that would enable him to comprehend the situation described in the picture. His greatest difficulty was in perceiving the picture as a whole. He also had a gradual impression of the visual details, which he was unable to synthesize.

As was shown from the results on the subtests 'Gestalt Perception', 'Abstract Thinking with visual stimuli' and 'Metaphorical Language' (see Table 1), FN was deficient in abstract thinking when it came to visual stimuli and metaphorical language. Finally, because FN's writing skills were impaired, visuo-spatial construction assessment (BURNS right subtest: clock) was not testable. Also, he could not describe the route to a target-place, as requested.

Part B-extended evaluation

The neuropsychological examination involved the following tests: the Digit Span Forward of the Greek version of WAIS-R (Weschler, 1981), the Greek standardized version of Token Test (de Renzi and Vignolo, 1962) (see Table 2, as well as three tasks on naming and abstract thinking with visual stimuli (Word-Picture Matching — see Sehen—Denken—Sprechen)). In these tasks the patient had to match the correct written form of an object to a noun, and the written form of an action to a verb, picking from three pictures (one picture was the target word, one was semantically relevant to the target word and the last was semantically and phonetically irrelevant to the target word; he also had to pick and name among four pictures the one picture-word that did not semantically match the three others).

Responsive Naming and Visual Confrontation naming were sometimes possible, with difficulty but beyond his ability. He was able to match a picture to a word, only when the word to match was a noun. He showed deficit in action naming and in sentence completion. In particular, when given the verb "flies" with the instruction to match it to the appropriate picture, where he had to choose among a picture of some eggs, a bird and a cat, he was unable to perform the matching. He was able to name objects presented to him visually, as was shown in confrontation naming with nouns, but was totally deficient in naming any color at all. When presented with different colors and asked to point at yellow FN could not respond. The same happened with every other color requested (see Table 1). Additionally, FN was presented an apple and was asked what color that fruit was. He answered "correctly" (with a semantic paraphasia) that it had the color that was typical of a football team, (Greek correct form "εχει το χρώμα του Ολυμπιακού" suggesting the red color).

When he was shown a yellow object, he spontaneously answered again "correctly", by using the name of the football team (A.E.K.), whose distinctive color was yellow (his compensatory cues in everyday communication).

FN's reaction was very interesting while performing the Token Test (see Table 2). As he was administered the TT, (containing simple tasks and gradually getting more complex), in which he was requested to begin by executing simple tasks such as: "Show me the red square", FN was totally unable to respond to even the simplest of these requests. So we decided to administer the task the following way: Instead of asking him to show the red square, we asked him to show us the square which had the color of the specific Greek football team (with red as its distinctive color). The result was quite astonishing when FN answered all of the questions administered this way with no difficulty at all. Having established that the patient had spared color perception, discrimination and recognition, there was no doubt that he had difficulty to name colors, to associate the color of the visual stimuli with the stored color knowledge. It was, however, surprising that he had compensated for his deficit by using his own "football-team color-code".

Naming Tasks

Visual naming

The 60 line drawings taken from the Boston Naming Test (BNT; Kaplan *et al.*, 1983) were presented in their original B/W format. FN named 26 pictures correctly, without semantic or phonetic cues. He recognized and named 18 pictures with semantic cues and finally he named only 8 pictures with phonetic cues. He was also administered the two naming subtests (Short and Long Version) from the BORB Neuropsychological Battery (Riddoch and Humphreys, 1993). In the short version he named 10 B/W pictures, while in the long version he named 57 B/W pictures (see Table 2).

Naming to spoken definition

FN was administered the Vocabulary task from the WAIS-R (Weschler, 1981) in the reversed order, for example, "How do we call the coldest season of the year?" and so on. Administration was discontinued after 17 trials. He managed to respond correctly to 13 definitions, as described in Table 3.

Naming action from object

We administered 19 B/W pictures that presented objects we use in everyday life, such as scissors, book, toothbrush and so on. The task was administered in the following way: patient was asked 'What do we use a lock for?', while the specific picture was presented. FN was able to name the action/use of only the following 7 objects: scissors, saw, umbrella, bed, knife, book and cigarette.

Table 3. Naming to spoken definition

WAIS-R /Vocabulary Reversed	Definition	Scoring
We are sleeping on it. What is it?	<i>Bed</i>	1
It's sailing. What is it?	<i>Boat</i>	1
Europe's currency.	<i>Euro</i>	1
The coldest season of the year.	<i>Winter</i>	1
Our first meal in the morning.	<i>Breakfast</i>	0
When something is broken we are trying to...	<i>Repair</i>	0
Velvet, silk, cotton-wool, all are kinds of...	<i>Cloth</i>	0
The purpose of puzzle: I have to ... all the pieces.	<i>Put Together</i>	1
The biggest of all.	<i>Huge</i>	1
When you don't want anyone to find out something, then you try to...it.	<i>Hide</i>	1

Color processing tasks

1. Color Perception: see above his scoring in the Token Test.
2. Color naming from visual object: Patient was presented 10 colored objects, such as a banana, a carrot, a flower and so on. He was asked to name their color. His performance showed an impaired color naming, as he named only three out of ten (carrot, lemon and orange).
3. Color selection of low and highly diagnostic pictures: we administered 20 B/W pictures, 10 with low and 10 with highly diagnostic value. The patient was presented each picture, while provided with three color choices. Each time the most fitting color choice was evaluated with one point. The second most fitting color was evaluated with half point and the irrational color choice received 0 points. For example, presenting a round table the color choices were: brown (1 point), white (half point) and pink (0 points). Then he was encouraged to show the color he thought of as fitting best to the object presented. Out of the 10 low diagnostic objects, the patient selected the most fitting color for 4 pictures, while the second most fitting color for another 4, scoring a total of 6 points. Out of the 10 high diagnostic objects, the patient selected the most fitting color for 7 pictures, while the second most fitting color for another 2, scoring a total of 8 points (see table 4).
4. Testing the compensating football-team color-code: Finally, we constructed the following task in order to clarify the usage of the compensating strategy (see Table 5): We selected the ten most popular Greek football teams and asked FN to match the name of each football team with its distinguishing color. We then administered again the second processing task and again asked FN: "Tell us the names of the objects in any way you can." FN named 9 of the 10 items, using once more his football-team color-code (except for the star).

The research team intended to re-test the patient with new experiments. Unfortunately this was impossible because FN was reluctant to participate in further neuropsychological assessment.

Table 4. Color selection of pictures with highly and low diagnostic value

'Highly diagnostic' pictures		'Low diagnostic' pictures	
Visual Objects	Scoring	Visual Objects	Scoring
Banana	1	Bird	0
Brick	1	Chair	1
Broccoli	1	Fish	1
Carrot	1	Dog	1
Fire-engine	0	Sports car	1
Lemon	1	Hammer	0
Lettuce	1	Fork	0
Radish	0	Round table	0
Stop sign	1	Plate	0
Taxi	1	Nail	0
Total score	8/10	Total score	4/10

Table 5. FN's 'football-team color-code'

Greek football teams	Representative colors
A.E.K.	yellow on black
A.R.I.S.	yellow on black
KALLITHEA	purple on white
AKRATITOS	dark green on white
PANATHINAIKOS	green on white
IONIKOS	blue on white
OLIMPIAKOS	red on white
O.F.I.	grey/black on white
P.A.O.K.	black on white
IRAKLIS	navy blue on white

Discussion

At the time of our first observation FN displayed all the typical symptoms of color anomia and some symptoms indicative of optic aphasia. Moreover, the neuropsychological evaluation showed deficits in other cognitive domains as well. His reading was impaired, he performed letter-by-letter reading

and he exhibited difficulties in comprehending complex sentences and instructions. His numerical reasoning was defective, as well as his ability to copy drawings and shapes, due to weakness in his right hand resulting from ischemic infarcts.

In general, FN exhibited communicative effectiveness during conversation. He demonstrated appropriate social affect with regard to facial expressions, eye contact and interest in verbal interactions, though he did not use many spontaneous gestures because of his physical exhaustion. On the other hand, FN was able to identify the emotion of the examiner on three out of five sentences based on the prosodic feature of the statement (as shown in Table 1).

FN's comprehension ability was at satisfactory level. His oral comprehension skills at the word and sentence level were significantly stronger than his ability to understand information at the paragraph level. He made many errors on the Inference and Metaphorical Language Tasks, suggesting that his understanding of abstract language was reduced.

Among our patient's cognitive deficits the most striking feature was his inability to name colors presented to him visually and his inability to indicate or point to the color requested by the examiner. As Davidoff and de Bleser (1994) suggested, color anomia could be considered as a recognition disorder. The argument requires some elaboration on the functional and logical difference among colors, objects and colors of objects. The categorization of color from the temporary representation can be performed independently of shape (Levine *et al.*, 1985; Ojemann, 1994; Carlesimo *et al.*, 1998; Brown and Hagoort, 2003) and, hence, color naming requires a functional route between the temporary (uncategorized) representation and the output lexicon, which is distinct from that for object naming (Davidoff and de Bleser, 1994). Thus, the term color anomia should be restricted to those impairments resulting from neural damage, after successful color categorization (Fadda *et al.*, 1998; Miceli *et al.*, 2001), as functioning in the case of FN and his compensatory strategy for color naming. This means that FN's deficit could not be considered as a recognition disorder, but as an impaired access to color names in the phonological output system, and a relatively spared information of knowledge related to the semantic system, as indicated from his compensatory 'color-code' strategy (Lissauer, 1980; Luzzati and Davidoff, 1994). Following the terminology of Roberson *et al.* (1999), FN seemed to make both use of perceptual and categorical similarity judgments according to task demands. Furthermore, we could not claim that FN's compensatory strategy is simply frequency based rather than categorical, since he could name both nonfrequent words (like *put together* all pieces of a puzzle, see Table 3), as well as infrequent objects with low color diagnostic value, as *fish*, *sports car* and so on. Therefore, he was able to name both highly familiar items as well as less familiar ones (i.e. *sports car*, *boat*, etc., see Table 4). More on frequency count for these specific Greek words (which is obviously different from the

English language) can be found on the web site of the Institute for Language and Speech Processing, at www.ilsp.gr/productsgr.html.

Our patient's inability to retrieve color names could not be attributed to impaired visual color perception, impaired visuo-color recognition or impaired color knowledge, as indicated from his scoring in the used tests. We speculate that our patient's deficit resulted from impaired access to color names in the phonologic output system (Fukatsu *et al.*, 1999). In agreement with other authors (Ojemann, 1994; Lesak, 1997), we assume that our patient's paracallosal lesion prevents semantic information about visually presented colors, processed by the right occipito-temporal region, from being transferred to the language areas on the left hemisphere (Farah *et al.*, 1998; Plaut, 2002). In the case of visual-input naming impairment, it is not just the input modality that counts, but also the type of stimulus presented. Stimulus naming depends upon what pathways are used during semantic processing (Ferreira *et al.*, 1997).

Finally, the visual-semantic disconnection exhibited by FN for colors appeared to be bi-directional. While he was totally deficient in providing names of colors and pointing to them correctly, he was able to perform both tasks when the examiner used the patient's 'color-code', thus making a semantic change. These results demonstrate that the mechanisms underlying color perception and naming are separable from those representing color knowledge (Humphrey and Riddoch, 1984, 1985; Shuren *et al.*, 1996; Bartolomeo *et al.*, 1997).

The strategy he had developed for compensating for his inability to name colors was the most interesting of all his characteristics. Specifically, being a fanatic sports fan, FN developed high color diagnosticity for football-teams. Color diagnosticity, the extend to which an object is associated with a color, is not only a simple perceptual effect resulting from daily stimuli, but it also depends on personal values and interests. We therefore might assume that perhaps football team names, being of higher interest to him, are of higher familiarity to him than use of color names and, eventually, that is the reason why he can retrieve football names instead of color names. Thus, he created a unique communication code, which he applied to all colored stimuli in general. FN's compensating strategy is the best proof that damage to a neural system should not restrict the patient into experiencing a noncolored world, but that we should seriously take into account the patient's special capabilities or interests in order to find a way, his own code, to communicate with other people.

Our final consideration concerns the implications in the cognitive rehabilitation domain. Social events and cues, such as sport-activities and the psychological investment which results from the fans' involvement, should be considered in order to develop a suitable intervention program. The above conclusion makes the neuropsychological evaluation a unique and precious tool, when working in this direction.

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