ON THE DISCRIMINATION OF COLORS AND THE NON-UNIVERSALITY OF BASIC COLOR TERMS

DESPRE DISCRIMINAREA CULORILOR ŞI PARTICULARITATEA TERMENILOR PRIVIND CULORILE DE BAZĂ

(Rezumat)

Cercetările recente despre percepţie au evidenţiat faptul că anumite categorii lingvistice influenţează discriminarea culorilor, demonstrând categoric că există un avantaj discriminatoriu bazat pe limbă (Winawer et al. 2007, Tan et al. 2008, Athanasopoulos et al. 2009). Paradoxal, avantajul discriminatoriu dispare sub constrângerea unei cerinţe verbale, dar nu spaţiale, simultane, sugerând că efectele limbajului despre aparatul cognitiv se manifestă în mediul *online* (Winawer et al. 2007, Lupyan 2012). Potrivit unor cercetători, avantajul pare să fie obţinut mai ales în câmpul vizual drept (Gilbert et al. 2006, Drivonikou et al. 2007), dar nu se acceptă „lateralizarea" la nivel general (Witzel and Gegenfurtner 2011). Rezultatele empirice conduc la concluzia că teoriile universalităţii lingvistice şi ale categorisirii culorilor de bază sunt nesustenabile.

Key-words: color discrimination, color perception, color categorization.
Cuvinte-cheie: discriminarea culorilor, percepţia culorilor, categorisirea culorilor.

A great deal of empirical study over the past decade has examined the Whorfian question at the center the color debate, namely, the assertion that language affects our perception of the world. Recent findings have revealed unambiguously that linguistic categories do indeed influence color perception. The language with which we "label" colors, as it were, influences how we see them. More specifically, a measurable discriminatory advantage obtains across but not within different color categories in different languages. Paradoxically, the language-induced advantage is eliminated through verbal, but not spatial, interference, suggesting that language is online (Winawer et al. 2007) or otherwise interacts with perception (Lupyan 2012, citing Kemmerer 2010). Additional findings suggest that the discriminatory advantage pertains

to, or is preferential in, the right visual field (Gilbert et al. 2006, Drivonikou et al. 2007), though this finding has not been replicated consistently and, thus, has generated controversy.

In what follows I will contextualize and focus on two seminal studies that have driven the current empirical research in color perception, discuss briefly some replications and extensions of them, and then address theoretical considerations in a broader cognitive context. I argue that a universalist position cannot account for color perception in light of the recent findings.

Universality as categorization

The color debate began in earnest with the appearance of the BCT paradigm (Berlin and Kay 1969)[1]. On one side of the debate, universalists take color perception as a function of underlying semantic universals, claiming: "the semantics of color display substantial linguistic universals … [which] are based on panhuman neurophysiological processes in the perception of color" (Kay and McDaniel 1978: 638). Critics of BCT research, on the other hand, claim methodological circularity and a lack of attention to important details, most notably, nonchromatic qualities of color, and referential range and formal distribution of color terminology (e.g. Saunders and J. van Brakel 1988, Lucy 1997)[2]. In the 1990s. the color debate shifted to more cognitive domains, playing out notably in a special issue of *Behavioral and Brain Sciences,* in which thirty-two respondents to a target article (Saunders and van Brakel 1997), including Kay and Berlin (1997), examined the nature of constraints on the categorization of colors.

More recently, the universalist position was re-asserted in two companion pieces:

> "Four separate lines of argument meet to clarify, highlight, and embolden a universalist perspective on basic hue categorization of red, yellow, green and blue" (Bornstein 2006: 56); "… I assess the development of categorization to naming regularities and possible mechanisms for how we get from the start – universal biologically

[1] See Saunders (1999) for a summary of predecessors to Berlin and Kay (1969) and Saunders (2000) for a discussion of modifications subsequent to the original BCT paradigm.

[2] Wierzbicka (2006: 2) flatly reject that the concept of color is universal, pointing out that a great many languages do not allow the question "what color is this?"

> grounded basic categorizations of hue – to the end – cultural variation in basic color naming" (Bornstein 2007: 3).

This view of color perception assumes a linear model of processing whereby categorization is taken to underlie and feed language. Conversely, color "naming" refers to the mapping of language onto pre-existing, universal categories. The argumentation rests on the fact that categorization is pre-linguistic[3]: "human infants, long before the acquisition of language or culture, and various infrahuman species that see color, but which are devoid of language and culture, also partition the spectral continuum into basic categories of hue" (Bornstein 2006: 56).

But what happens when language comes online in the brain? Bornstein fails to consider the enormous differences in capacity, functionality and connectivity that infant brains undergo relative to adult brains (Fair et al. 2009). The Whorfian question is *per impossible* for pre-linguistic infants, whose brains simply cannot tell us how language impacts cognition.

Empirical evidence of categorical perception

Winawer et al. (2007) tested monolingual Russian and English speakers' ability to discriminate different blue colors. Since Russian speakers have two linguistic categories for blue: *goluboj* for 'light blues' and *siniy* for 'dark blues', neither of which is a subset of the other, they examined whether this language-specific boundary impacted speakers' ability to discriminate across and within categories.

Informants were presented with color triads of two different blue colors and asked to decide as quickly as possible whether a top color matched a bottom color on the left or right. By controlling for color boundaries systematically and measuring reaction times comparatively, they found a measurable discriminatory advantage for Russian speakers compared to English speakers.

[3] Bornstein also invokes a "high degree of unity and regularity" of color terminology across language and cultures, i.e. the very universalism that he is purporting to support, and neurophysiological responsiveness, which by his own admission is inconclusive: "physiological responsiveness to neural pathways in the visual system shows patterns of wave length discriminability that appear compatible with (and suggestively determinative of) basic hue categories" (2006: 56).

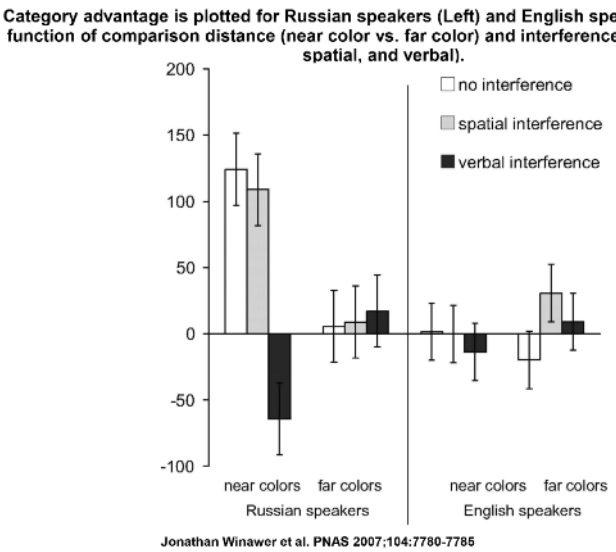

Figure 1: Categorical perception in monolingual Russian speakers (Winawer et al. 2007, Figure 3)

Reaction times on within-category discriminations, i.e. within *goluboj* or within *siniy*, were slower than those across the *goluboj / siniy* boundary, and the categorical effects were more pronounced for more difficult discriminations. English speakers tested on the same stimuli showed no advantage under any condition, though their light blue / dark blue boundary was "nearly identical" (7781) to the *goluboj* / *siniy* boundary. It was further noted that the discriminatory advantage was eliminated by a dual verbal task[4], but not by a dual spatial task, leading to the conclusion: "… (i) categories in language affect performance on simple perceptual color tasks and (ii) the effect of language is online (and can be disrupted by verbal interference)" (7780).That a language-induced advantage can be negated by verbal interference has theoretical implications for cognition, which I address below.

Replication studies confirmed and extended these results. In a color oddball paradigm task for monolingual Greek speakers, who also have two categorical blues, categorical perception obtained with electrophysiological evidence of "automatic" processing of blue compared to green:

> "...findings unequivocally show a discrimination advantage for cross-category over within-category stimuli consistent with the individual's [*sic*]

[4] Subjects were given a sequence of digits to rehearse, and later recall, while completing the color trials.

> linguistic partition of the color spectrum" (Athanasopoulos et al. 2009: 332); "[The] vMMN, [which is] an index of automatic and preattentive change detection, was ... significantly larger for blue than green deviant stimuli in native speakers of Greek" (Thierry et al. 2009: 4567)[5].

Similarly, a study of Mandarin Chinese found automatic activation of the left posterior temporoparietal regions responsible for word-finding during a color discrimination task, yielding the conclusion: "...language-processing areas of the brain are directly involved in visual perceptual decision, thus providing neuroimaging support for the Whorf hypothesis" (Tan et al. 2008: 4007). Evidence suggests further that newly trained linguistic categories exert a similar categorical effect (Zhou et al. 2010; see discussion on lateralization below). In short, empirical findings reveal behavior, neurophysiological and electrophysiological evidence of categorical perception, i.e. that linguistic categories impact perception. Less clear, however, are findings that suggest a lateralized effect in color perception.

Lateralization in color perception

In a second, seminal study, Gilbert et al. (2006) considered functional organization of the brain in color perception, reasoning that if language affects perception, it should do so more in the right visual field. They conclude: "It appears that people view the right (but not the left) half of their visual world through the lens of their native language, providing an unexpected resolution to the language-and-thought debate" (Gilbert et al. 2006: 489).

This finding also generated considerable interest. Evidence of lateralization (with concomitant theoretical underpinnings) has been reported (e.g. Siok et al. 2009, Zhou et al. 2010), but the majority of replication studies since Gilbert et al. (2006) have found categorical perception in both visual fields. Drivonikou et al. (2007) was one of the first to do so: "...although we find Whorfian effects on color are stronger for stimuli in the right visual field than in the LVF, we find that there are significant category effects in the LVF as well" (1097). Roberson et al. (2008: 752) found likewise for Korean, which, like Russian and Greek, has two categories of blue, concluding further: "… the CP [categorical perception] effect in the left visual field cannot be taken as evidence for universal categories" (761). The most comprehensive study on lateralization in this context is that of Witzel & Gegenfurtner (2011), who ran ten versions of the original experiments from Gilbert et al. (2006) and Drivonikou et al. (2007). Their conclusion was unambiguous: "For all our sets of stimulus colors, our results exhibited the classical pattern of reaction times

[5] The two quotes reproduced here refer to the same experimental study; the respective publications have a different first author.

considered to be a category effect in the original studies. However, none of these effects were lateralized." (Witzel & Gegenfurtner 2011: 21).

Theoretical considerations

One reason for the considerable interest in lateralization, doubtless, was theoretical in nature: if categorical perception obtains only in the right visual field (i.e. the left hemisphere), then the universalist position can still be claimed for the right hemisphere. This position is still to be found, but it is often articulated in an ambiguous and tenuous way, as evidenced by the following statement (co-authored by one of the founders of the BCT paradigm): "color naming across languages does reflect universal tendencies, as shown in earlier work – but also some degree of local linguistic convention" (Regier & Kay 2009: 439). It is fair to state, at the least, that the original claim of panhuman linguistic universality associated with BCT research has been, perforce, recast in light of recent empirical work. We have in this context a striking example of empiricism driving theory, and reference to old theoretical tenents such as "universal tendencies" no longer suffice.

More striking to Lupyan (2012) is the finding from much of the empirical work, including Gilbert et al. (2006) and Winawer et al. (2007), that verbal interference negates categorical perception: "...it is indeed puzzling how the sorts of effects of language on color categorization and perception ... can be simultaneously pervasive and fragile: if language alters concepts, should not these altered concepts persist regardless of how language is deployed on-line?"[6] (Lupyan 2012: 3). In addressing this paradox, he rejects verbal / non-verbal representations of processing in favor interactivity, asserting that many putatively non-verbal tasks are, in fact, modulated by language (2012: 9), noting also that similar effects have been shown for other cognitive domains, including motion perception, visual search, simple visual detection, recognition memory and relational thinking (2012: 1, see also Lupyan and Ward 2013). In the broader cognitive context, color perception happens to provide a striking example of the effect of language on perception.

Lupyan's solution to this paradox to propose (as "merely a sketch") an interactive model of processing: "The *label-feedback hypothesis* proposes that language produces *transient* modulation of ongoing perceptual (and higher-level) processing", which is flexible and task-dependent (Lupyan 2012: 3)[7]. For Lupyan, a linear or hierarchical view of cognition is part of the problem: "a pervasive source of theoretical confusion regarding effects of language on cognition and perception stems from a failure to appreciate the degree to which

[6] Elsewhere he poses this question in Whorfian terms: "if effects of language on perceptual processing are "Whorfian" in the sense of changing the underlying perceptual space (i.e. warping perception), then how can the space be "unwarped" so easily?" (2012: 3).

virtually all cognitive and perceptual tasks reflect interactive-processing, combining bottom-up and top-down sources of information." (Lupyan 2012: 10).

Conclusion

The terms of what used to be called the color debate have changed radically in light of empirical evidence that demonstrates a language-induced effect on the perception of colors. Universality cannot account for categorical perception and, therefore, is untenable as a theory for color perception. I would argue that no theory of color perception can be said to be valid that does not take into account the measurable discriminatory advantage found consistently in recent empirical research in color perception. The Whorfian question at the heart of the color debate can be said to obtain with respect to perceptual tasks involving color discrimination. Similar findings in a growing body of literature suggest that a dynamic model of cognitive processing is required to account for the effects of language on a wide variety of cognitive tasks.

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[7] He notes that this view does not imply that cognitive processes are always under linguistic control (2012: 3). Rather, it simply means that the adult brain learns to make use of language, which can and does interact with other cognitive processes.

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Brian IMHOFF
Texas A&M University
College Station, Texas USA