Color naming

[Definition]

Color naming consists in assigning a color name, such as “red” or “blue”, to a concrete color one sees (or saw) in the environment. Such a concrete color may be perceived as part of a particular object’s appearance, such as the yellow color of a banana, or a color sample that represents color by itself, such as encountered when choosing a color in a clothing catalogue. This definition might seem simple and self-speaking. However, the mental performance of color naming is not trivial at all since it involves two kinds of transformations. On the one hand, the perception of color is based on three perceptual parameters: hue, saturation and brightness. Color naming combines these parameters to just one level of feature comparison, namely the color names. On the other hand, each of these three parameters varies continuously. Color naming transforms this continuous color space into distinct color categories, to which we assign a word. Taken together this allows us to distinguish millions of different colors, but commonly use only a restricted number of color names when communicating about all these colors. For example, parts of a banana may be darker and less saturated due to shading; parts may also be more yellow-greenish or more yellow-orangish. Yet we perceive all these different shades of colors as belonging to the same category “yellow” and speak about the “yellow” banana.

[Research]

In research, “color naming” may be understood in two different ways. On the one hand, color naming is a psychological phenomenon studied as an object of research by itself. In this case, the ultimate question at stake is how human perception succeeds in the partition of the perceptual continuum into discrete, linguistically defined categories. In this way, color naming research is related to research about perception, categorization and communication. In order to study color names as an object of research, they have been operationalized as so-called *Basic Color Terms* (Berlin & Kay, 1969). In an attempt to allow the scientific comparison of different color names within and across languages, four properties have been defined to characterize such Basic Color Terms as rigorously as possible. When applied to the English language, this definition results in eleven Basic Colour Terms. These are black, white, red, yellow, green, blue, gray, orange, brown, pink and purple. These Basic Color Terms contrast color names such as “dark blue” (*polylexemic*), “turquoise” (*inconsistent*), “blonde” (*context dependent*) or “claret” (*hyponymic*). Even though it has been questioned that Basic Colour Terms correspond to well-defined phenomena that exist in all languages in the same way (Levinson, 1997), research on colour naming has proven Basic Color Terms to be a very useful means of analysis. On the other hand, color naming is a method used in psychological experiments in order to obtain a scientifically controlled distribution of people’s color categories over color space. Typical color naming tasks aim at determining the typical colors and the boundaries of color categories. People are supposed either to assign names to colors or, inversely, to assign colors to names. In the first case, they name single samples of color by choosing one of an ensemble of color names; in the second, they pick color samples that correspond to a particular color name out of an ensemble of color samples. A special variant of a color naming task is “hue scaling”, where observers rate the amount of red, green, blue, and yellow in the stimulus. This method shows that people are not only sensible to the typicality of color categories but also to the contributions of different linguistically defined color categories to concrete samples of color.

[History/Development]

Historically, research on color naming has been developed out of two different research backgrounds. One tradition of research has been the empirical verification of the so-called Sapir-Whorf-Hypothesis. This hypothesis consists in the assumption of linguistic relativity and

linguistic determination. Linguistic relativity refers to the assumption that the world is differently experienced and conceived in different linguistic communities. Linguistic determination postulates that language influences perception and thinking. These assumptions also imply an epistemological issue: If the Sapir-Whorf-Hypothesis was true this could put into question the researchers' objectivity by relativizeing the researchers' concepts to their cultural origin. This might also be part of the reason why this hypothesis has been discussed so hotly (Levinson, 2003). With the work of Lenneberg and Brown (Brown & Lenneberg, 1954; Lenneberg, 1953; Lenneberg & Roberts, 1956) research about color naming reached an exemplary status due to the obvious discrepancy between the continuity of color perception and the discreteness of linguistic color categories. Thereby, research about color naming has been reframed into issues concerning the *Nature-Nurture-Debate*. In this context, the genetic determination (*nature*) of universal color categories has been opposed to their cultural determination (*nurture*). Since the first empirical studies by the cultural anthropologists Berlin & Kay (1969), it has been debated whether the eleven English color names represent the complete set of possible Basic Color Terms. From this perspective, in other languages the number of Basic Color Terms and the labels may differ. But the colors, to which the labels refer, would always be sample out of this set of universal Basic Color Terms. It has also been postulated that these universal Basic Color Terms can be grouped and ordered to reflect their appearance during cultural evolution (Bolton, 1978; Bolton & Crisp, 1979; Kay, 1975; Witkowski & Brown, 1977) as follows: (black, white) → (red) → (yellow, green) → (blue) → (gray, orange, brown, pink, purple).[i] The second background for research on color naming has been vision research. In this domain, color naming has been related to how the visual system processes wavelength combinations. The epistemic interest in this tradition has been how the high-level, cognitive phenomena of color naming relate to more low-level, sensory phenomena (for example Bornstein, 1973; Sternheim & Boynton, 1966).
These traditions of research have cultivated three different main approaches: firstly, the approach of cross-cultural comparison that emanated out of the anthropologist tradition; secondly, the psychophysical approach that developed out of vision research; thirdly, a developmental approach that has supplemented color naming research with insights about how color names and color vision are interrelated in child development (e.g. Bornstein, Kessen, & Weiskopf, 1976; Lumsden, 1985; Mervis, Catlin, & Rosch, 1975). Furthermore, new approaches inspired by engineering and computer science have applied simulation methods for the evolution of color names (s. below).

[Achievements]

The different approaches towards color naming research have led to a common pool of different kinds of data about color naming.
Up to now, several cross-cultural comparisons, including the extensive World Color Survey (WCS), have shown that there is indeed a certain stability of Basic Color Terms across different languages (Kay & Regier, 2003; Lindsey & Brown, 2006; Regier, Kay, & Cook, 2005). This is true for category prototypes, much less though for category boundaries. At the same time, it is also clear that there is still some variability of Basic Color Terms across different languages (Kuehni, 2007; Roberson, Davidoff, Davies, & Shapiro, 2005; Roberson & Hanley, 2007; Uusküla, 2006). Furthermore, the colors that correspond to the Basic Color Terms also vary interindividually within a linguistic community. However, they are comparatively stable across contexts for the same observers (Hansen, Walter, & Gegenfurtner, 2007). Finally, these Basic Color Terms are surprisingly stable over time within an individual in the same context.
Furthermore, we also know today that the Basic Color Terms in other languages may differ in at least two ways from the set of possible Basic Color terms originally claimed to be universal. On the one hand, there are languages with more than eleven Basic Color Terms. Russian for example has a supplementary Basic Color Term to distinguish between "light

blue" (*goluboy*) and "dark blue" (*siniy*) (Davies & Corbett, 1994; Davies, Corbett, McGurk, & MacDermid, 1998; Paramei, 2005). Korean even provides fifteen Basic Color Terms (Kim, Pak, & Lee, 2001; Pak, Kim, Kim, & Lee, 2004). On the other, there are also languages that merge the category of "blue" and "green" to one Basic Color Term, a phenomenon that has been circumscribed as "grue" (Berlin & Berlin, 1975; MacLaury, 1997).

In view of the cross-cultural stability, it has been shown that the stability of color categories is not necessarily a sign of pure genetic determinism. This stability may also emerge through the interplay of three types of determinants: Learning through the confrontation with the distribution of colors in the environment (empiricist learning), learning through social interaction in the context of linguistic communication (cultural learning) as well as physiologically hard-wired preconditions (Belpaeme & Bleys, 2005; Dowman, 2007; Jameson, 2005; Kirby, Dowman, & Griffiths, 2007; Komarova, Jameson, & Narens, 2007).

Finally, it also became clear that there is a so-called category effect in terms of reaction times. This means that in color discrimination tasks, people are faster if the two colors to be discriminated belong to two different categories than when they belong to the same one (Drivonikou et al., 2007; Gilbert, Regier, Kay, & Ivry, 2006; Roberson, Pak, & Hanley, 2008; Winawer et al., 2007; Witthoft et al., 2003).

[State of the art]

Today, the opposition between universal vs. variable (or culturally relative) color names has shifted to a new core question. This question asks where stability may come from and how physiological, cultural and empirical determinants interact to bring about a particular set of color categories and names.

Another important question remains whether empirical phenomena like the aforementioned category effect reflect categorical perception (Pilling, Wiggett, Özgen, & Davies, 2003). Categorical perception is a discontinuity in perception at the category borders. For these phenomena the question arises how they originate in regard to physiological, cultural or learning constraints (Kay & Regier, 2006). Like in vision research in general, the question about the relationship between color perception and naming on the one hand and other perceptual phenomena such as word interpretation (Smithson, Khan, Sharpe, & Stockman, 2006), object recognition (Mitterer & de Ruiter, 2008; Naor-Raz, Tarr, & Kersten, 2003) and color constancy (Hansen et al., 2007), has become crucial.

Finally, a neural correlate of the color categories is also a topic of intense research. At present, results support the view that in early visual areas V1-V4 basic color categories do not have a special status (Gegenfurtner, 2003). A potential candidate area for the representation of color categories is an area in the inferior temporal cortex IT.

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[i] In personal communications people brought also up the idea that this evolutionary sequence has also been shown for concept development in childhood; I did not find an article that tries to show this.