

Thinking Colours

Thinking Colours

Perception, Translation and Representation

Edited by

Victoria Bogushevskaya
and Elisabetta Colla

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«A construção de “adolescência” no romance juvenil alemão e português: uma leitura de *Die Zeit der schlafenden Hunde*, de Mirjam Pressler, e de *A Lua de Joana*, de Maria Teresa Maia Gonzalez», Azevedo, Fernando, Mesquita, Armindo, Balça, Ângela e Silva, Sara (coord.),

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«Die Konstruktion von “Adoleszenzidentität” im deutschen und portugiesischen Jugendroman: eine transkulturelle Lektüre der Bücher Crazy von Benjamin Lebert und Rafa e as férias de Verão von Fátima Pombo», Real – Revista de Estudos Alemães, Em Trânsito–Übergänge. Grenzen überschreiten in der Germanistik, <http://real.fl.ul.pt/textos.page>.

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The "monochrome" of Giovanni Maria Falconetto, in AAVV, *Chromoland*, Verona 2012.

INTRODUCTION¹

*La tendance dominante de la couleur doit être de servir le mieux possible
l'expression.*
—Henri Matisse

In his “Notes of a Painter” (1908) Henry Matisse states that “the chief function of colour should be to serve expression as well as possible” (Flam 1995). Matisse had an innate capability of blending words and colours as if parts of the same dimension. This concept, however, is truly antique and draws our memory back to a Classical Latin expression attributed to Horace “*ut pictura poesis*”². Colours and words are the two factors that come into play in processes of “negotiation” (Eco 2003) between the world and its linguistic representation.

Before getting categorized, interpreted and having its meaning assigned, any environmental phenomenon is primarily detected by our sensory system. Vision provides us with the major part of the sensorial information we build up from the surrounding reality. This includes the actual scope for perceiving colour. Furthermore, in the process of visual perception, other senses are constantly involved to provide an integrated representation of the phenomena, which is encoded in memory and shared by a culture. That is why, “when one utters a colour term, one is not directly pointing to a state of the world, but is connecting or correlating that term with a cultural unit or concept” (Eco 1985). Translation must, first of all, respect the principle of equivalence. However, in the process of translation—as in any kind of negotiation—there is a certain loss of original meaning and a subsequent adjustment of signification. Representation is the production of meaning through language. In

¹This volume was inspired by the conference “Thinking Colours: Perception, Translation and Representation” held in Lisbon in March 2012, organized by the Center for Communication and Culture (CECC) of the Portuguese Catholic University and with the financial support of the Fundação para Ciência e a Tecnologia (FCT-Portugal). This event was made possible thanks to the efforts of a multidisciplinary team coordinated by Peter Hanenberg and composed of Ana Margarida Abrantes, Victoria Bogushevskaya, Ana Cristina Cachola, Elisabetta Colla and Verena Lindemann.

² *Lit.* “as is painting so is poetry”.

representation, we use signs, organized into languages of different kinds, to communicate meaningfully with others (Hall 1997).

The essays collected into this volume are organized into five interrelating sections exploring the discourse on the interaction between sensation, perceptions of colour and the various forms of its cultural representation. The contributors analyse the aspects related to colour ‘labelling’, its mediation and representation, consider traditional and new approaches and explore the cultural productivity of colour across different fields. Colour is presented within a conceptual framework that fosters alliances between the humanities and the social and natural sciences.

The place where science meets the humanities is cognitive culture studies (Hanenberg 2011), and this is where our book begins: Part I is dedicated to studying colour from a cognitive perspective. It opens with an article by **Anne Reboul** that provides the results of neuro-scientific experiments on colour categorization, interpreted as favourable to the Sapir-Whorf hypothesis. **Maria Rukodelnikova** studies canons and stereotypes of female beauty in both Chinese and Western cultures.

Part II contains essays dealing with issues surrounding the translation of colour lexicons and covers topics such as composite colour categories in Chinese by **Victoria Bogushevskaya** and colour metonymy in advertising by **Alena Anishchanka, Dirk Speelman and Dirk Geeraerts**.

The papers grouped in Part III explore the negotiation that occurs between colours and literature in a masterpiece of Chinese literary criticism *Wenxin Diaolong (The Literary Mind and the Carving of Dragons)* by Liu Xie (**Elisabetta Colla**), colour metaphors in Homeric epics (**Yukiko Saito**) and finally the interpretation of colour in the modern Portuguese youth novels “Uma Questão de Cor” and “Bauilha e Chocolate” (**Amélia Cruz**).

Colour in the visual arts constitutes Part IV that begins with an article by **Pedro Calapez**, the Portuguese visual artist renowned for his use of vivid colours and the optical effects they create, and where he explains how he uses materials to challenge viewers. **Reinhold Görling**’s study is dedicated to the semiotics and psychological effects of RED in cinema. **Marcia Marques** and **Anabela Mendes** analyze the associative meanings of colour in the works of famous painters as well as their theories of colour.

The studies in Part V emphasize the usage of colour and colour preferences within different cultural (**Surajit Chakravarty** and **Patricia Ball**) and social environments, including peculiarities in design and architecture (**Pietro Zennaro** and **Katia Gasparini**; **Alessandro Premier**;

Manuela Zorzi) and the symbolism of colour in tourism (**Maria João Cordeiro**).

Many of the questions addressed throughout this volume stem from the dialogic interaction among the contributors representing various different fields of research. We hope that the readers come away with a deeper understanding of two messages. First, the categorization and the interpretation of colour are *a priori* emotional and vary from culture to culture. Colour names have their own “cultural memory” and references, they can either “remember” or “forget” some notions relevant to the speakers’ cultural tradition. Second, as a cultural puzzle, colour produces very strong associative and symbolic meanings and thus ensuring it remains a strong semiotic resource and a powerful instrument for conveying and communicating meaning.

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COLOUR AND COGNITION

A NEW LOOK ON THE SAPIR-WHORF HYPOTHESIS ON COLOURS, BASED ON NEUROSCIENTIFIC DATA

ANNE REBOUL

Introduction

Sapir and Whorf (the latter being the student and disciple of the former) were American linguists who specialized in the Amerindian languages of North America, working throughout the first half of the last century. These languages are highly different from European languages, such as English. Notably, they have no tense morphology, a fact that led Sapir and Whorf to the very strong claim that Amerindians themselves had no sense of time. Moreover, this also led them to a more general hypothesis, known as the "Sapir-Whorf hypothesis", according to which language is *the* determinant of cognition, understood as the way people perceive the world. In as much as languages differ, the people speaking them will (literally) perceive the world differently. More specifically, "human beings do not live in the objective world alone, nor alone in the world of social activity as ordinarily understood, but are very much at the mercy of the particular language which has become the medium of expression for their society. *The worlds in which different societies live are distinct worlds, not merely the same worlds with different labels attached*" (Sapir 1958, 69. My emphasis). Furthermore, in Whorf's version, "we dissect nature along the lines laid down by our native languages. The categories and types that we isolate from the world of phenomena we do not find there because they stare every observer in the face; on the contrary, *the world is presented in a kaleidoscopic flux of impressions which has to be organized by our minds – and this means largely by the linguistic systems in our minds*" (Whorf 1956, 213-214. My emphasis). In other words, the human mind is a blank slate that language fills and enables not only to think but also to conceptualize and to categorize the furniture of the world; that is, without language, there are no concepts and no categories and only a medley of sensations.

The problem with general principles is that they can too easily be satisfied to actually prove interesting, i.e., they often are trivial. The Sapir-Whorf hypothesis can indeed be weakly verified, in which case, it would be trivial. Hence, the first thing to do is to examine the conditions that should be met for the hypothesis not to be trivial.

The Sapir-Whorf hypothesis is bi-dimensional in the sense that it predicts an asymmetrical co-variation – concepts will vary depending on the language spoken, while the reverse is not true –, and has an explanatory goal – it is *because* of the language spoken that a given human group holds the concepts it has. This suggests that the Sapir-Whorf hypothesis proves trivial should the co-variation not be constrained by some condition, to be formulated below, and/or if there is an alternative and more general explanation for it.

I shall cash out the co-variation in terms of the philosophical notion of *supervenience* that may informally be defined as follows:

"A set of properties *A* *supervenes* upon another set *B* just in case no two things can differ with respect to *A*-properties without also differing with respect to their *B*-properties. In slogan form, 'there cannot be an *A*-difference without a *B*-difference'" (McLaughlin and Bennett 2011, p. 1).

Regarding co-variation or supervenience, triviality or relevance will depend on how either the supervening or the subvening properties are defined. On the Sapir-Whorf hypothesis, the subvening properties are fairly straightforward: they are linguistic forms (from syntactic structures to classes of lexical items). The definition of the supervening properties, i.e., the cognitive properties, raises the problematic dimension. There are indeed two types of descriptions of these supervening cognitive properties:

- in terms of *ability*: a given cognitive ability can exist in a given population with its specific language if and only if the relevant corresponding linguistic form exists;
- in terms of *facilitation*: the ability exists in all cases (regardless of the language spoken), but the existence of the relevant linguistic form makes its exercise easier.

This, indeed, is where the availability of an alternative explanation comes in. Facilitation can be explained not through a direct link between language and cognition, but through the commonplace principle (from learning theory) that an ability improves when it is exercised (see Bloom et al. 1996). By contrast, no alternative explanation is available for the first interpretation. In other words, the Sapir-Whorf hypothesis is non-trivial

only if it can be shown that the relevant cognitive abilities co-vary with language relative to their existence rather than to their facilitation.

Thus, one can draw two predictions from the Sapir-Whorf hypothesis:

- a *trivial* prediction: the presence of a linguistic form in a given language will facilitate the exercise of the corresponding cognitive ability in its speakers;
- a *non-trivial* prediction: the absence of a linguistic form in a given language predicts the absence of the corresponding ability in its speakers.

Finally, we should be clear that testing the Sapir-Whorf hypothesis must be based on non-linguistic cognitive tasks in groups of people speaking languages that differ relative to the corresponding linguistic forms. This has been done in four domains: space, time, numerals and colour. I concentrate here on colour, before returning to the other topics in the conclusion.

Colour: preliminaries

Colours are the paramount example of what have been known in philosophy as *secondary qualities* ever since Locke. Basically, primary qualities are properties that objects have independent of any observer, while secondary qualities are properties that objects produce in people (typically sensations). While the first are objective, the second will at best be subject to inter-subjective agreement, but can indeed differ from one individual to the next. What is more, appearances to the contrary, colour is a continuum, the colour spectrum, with boundaries that seem rather arbitrary, as shown by the linguistic variations in the terms for colour.

In 1969, Berlin and Kay proposed that all languages have between two and eleven colour terms, following a hierarchy:

[white, black] + red + [(green + yellow) or (yellow + green)] + brown
+ [orange and/or pink and/or purple and/or grey]

In other words, languages with two words have black and white (dark vs. light), languages with three words add red, etcetera.

This fairly simple view has been completed and significantly complicated by the World Colour Survey (hereafter WCS) initiated by Stanford University. Responding to criticisms addressed to the initial study, mainly concentrating on the limitations of the linguistic survey

made, both in terms of number and variety of languages, the WCS has since collected data on colour terms in 110 languages spoken in non-industrial societies, from 2,616 informers, most of them monolingual. Using the Munsell scale¹, each informer was asked to perform two complementary tasks:

- name the colour when presented with a swatch (for all swatches on the scale);
- show the best example for a given colour on the scale.

The first task makes it possible to identify the colour boundaries for the language; the second makes it possible to identify the "centroid" (prototype) for the colour.

While the initial survey, by Berlin and Kay in 1969, had concluded to the universality of colour categories, the WCS yields a more complex picture:

- colour boundaries may differ importantly from one language to the next;
- however, colour centroids tend to gather together, despite the differences in boundaries.

A fairly natural interpretation is that centroids depend on basic colour perception, which, being biologically based, proves universal among humans with normal colour perception, while boundaries are less constrained by perceptual data. This, in itself, we should note, makes the strong Sapir-Whorf prediction unlikely, as it clearly reports that colour perception is largely independent of language. Furthermore, this is indeed what was found in an experiment comparing performances from English speakers and from Berinmo speakers (Davidoff et al. 1999). Berinmo and English speakers differ in the boundaries they draw on the colour spectrum. English makes a distinction between blue and green that Berinmo lacks. Berinmo contains a distinction between *nol* (blue+green) and *wor* (khaki+yellow) that English lacks. Participants were also tested on two non-linguistic tasks: discriminating between colour swatches (within and across linguistic colour categories); re-identifying a colour after a delay (a memory task, again within and across linguistic colour

¹ The Munsell scale is a colour scale organized along two dimensions: value, i.e., light vs. dark; and chromatic saturation (roughly, colours). It counts 330 swatches evenly spaced along these two dimensions.

categories). The results were not unexpected: discriminative perception was not affected by language, but memory was. Given the well-known links between language and memory (see Miller 1956), this is not surprising and clearly insufficient to support the non-trivial prediction of the Sapir-Whorf hypothesis given that language did not affect discrimination.

The neuro-scientific twist on colour

Adult studies

Colour perception is a typical example of *categorical perception*. Categorical perception occurs when two items on a perceptual continuum appear more distant than two other items on the same continuum even while the distance between the first is, in fact, equivalent to the distance between the second. For instance, the distance between two greens will seem less important than the distance between one of these greens and a blue, even when the distances are the same. In other words, categorical perception "warps" the perceptual space for colours, by lengthening the distance *across categories*, and shortening it *within a category*. The main question that neuro-scientific research has addressed is the brain localization of categorical perception for colours: is it localized in the left hemisphere of the brain, where language is primarily localized, or is it localized in the right hemisphere of the brain? The link with the Sapir-Whorf hypothesis is that this should predict that categorical perception, being by hypothesis language dependent, is lateralized in the left (language) hemisphere.

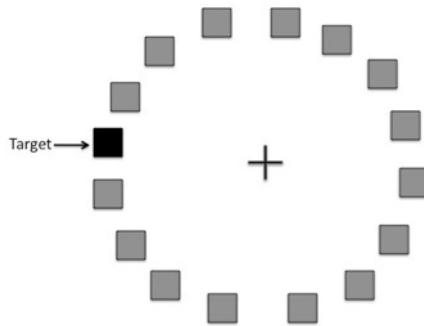
Neuro-cognitive investigations of the Sapir-Whorf hypothesis applied two complementary approaches: the lateralization of visual perception and interference. The first is based on the fact that the visual field can be divided into a left visual field and a right visual field. Though both eyes see the whole of the visual field (with a slight difference in angle of view that is the basis of depth perception in humans), due to the rather quirky organization of the human brain, information from the left visual field is treated in the right hemisphere of the brain, and information from the right visual field in the left hemisphere of the brain². The second, interference, is based on the fact that when participants are asked to perform task A that, by hypothesis, involves a given cognitive faculty (e.g. language), a good

² This does not mean that information cannot transit from one hemisphere to the next, but the first, early, treatment is lateralized as indicated.

test of the hypothesis is to ask them to simultaneously perform another task, B, which clearly involves that faculty. If B makes the performance of A more difficult, there is interference demonstrating that the faculty concerned is, indeed, implied in task A.

Neuro-scientific investigations have used very similar experimental materials: on a screen, participants see a circle made up of small squares appearing around a fixation cross, all squares being of the same colour apart from one, which is the *target* and which may appear in the right or in the left visual field (see Fig. 1, below):

Figure 1: the experimental set-up for lateralization



The task involves indicating by pressing a key on the computer keyboard whether the target appears on the left or on the right of the fixation cross. The target may be:

- a different colour in the same linguistic category as the other squares in the circle (e.g., another green);
- a different colour belonging to a different linguistic colour category (e.g., blue as opposed to green).

A first experiment (see Gilbert et al. 2006) used both lateralization and interference. It relied on four, evenly spaced, colours: two blues and two greens. There were two conditions: a no-interference condition in which participants only had to indicate which side of the circle the target appeared in by pressing one of two keys; an interference condition in which they had to do the same task and simultaneously repeat lexical

items³ that they heard through a headset. The predictions, based on the Sapir-Whorf hypothesis, were that, in the no-interference condition, a target from a different category (across category target) would be detected more quickly if presented in the right visual field (RVF) than if presented in the left visual field (LVF), while for a target from the same category (within category target), the field of presentation would have no effect. In the interference condition, these effects should disappear. These predictions were verified by the results. The results reported a significant asymmetry in reaction times in the no-interference condition depending on whether the targets were presented in the LVF or in the RVF for across category targets (reaction times were shorter for presentations in the RVF than for presentations in the LVF). No such asymmetry between fields of presentation was found for within category targets. In the interference condition, there was an asymmetry between fields of presentation but for both within and across category targets. However, when presented in the RVF, within category targets were now detected more quickly than across category targets. In other words, categorical perception for colours seems localized in the left (language) hemisphere of the brain. What is more, the strong interference effect shows that the language faculty is involved in colour perception in this non-linguistic task.

This first result was reinforced by a second study (see Siok et al. 2009), using the same paradigm (without the interference condition), but adding fMRI. This reproduced the behavioural results of the no-interference condition in the first study, with an asymmetry between presentations in the RVF and in the LVF for the across category target, and no such asymmetry for the within category target. The fMRI data showed that between category targets more quickly activated language areas in the left hemisphere, than did the within category targets.

The first two studies investigated lateralization of categorical perception among participants *from a single language*. This was remedied by a study (see Roberson et al. 2008) that concentrated on a colour distinction, found in Korean, but not in English, between two sorts of green: yellowish green vs. greenish green. Again, the study applied to four evenly spaced colours, two yellowish greens and two greenish greens, with the same paradigm as in the first study (without the interference condition). There were two groups of participants: English speakers (who do not have the distinction in their language) and Korean speakers (who do). The predictions were that the across-category targets would show the usual asymmetry between presentation in the RVF as opposed to presentation in the LVF in Korean

³ Not including colour words.

speakers, but not in English speakers. The results were at first disappointing in that, while the nature and presentation of targets made no difference in reaction times for the detection of the target in English speakers, as predicted, across category targets were indeed more quickly recognized by Korean speakers but this occurred regardless of the field of presentation. In other words, there was the same asymmetry in the RVF as in the LVF. However, a second analysis of the results of the Korean speakers brought out a distinction between a slow and a quick group. While in the slow group, the asymmetry was identical for across category targets in both visual fields, presumably because the information from the LVF had time to travel from the right to the left hemisphere of the brain, in the quick group, the usual RVF presentation effect was found in keeping with the results of the previous studies. Thus, the final conclusion of this study is that the language spoken bears a direct influence on the lateralization of categorical perception given that there was no lateralization (and no categorical perception) among the English speakers in contrast with the Korean speakers, who showed a left lateralization for categorical perception.

Before we turn to developmental data, what do these adult studies tell us about the Sapir-Whorf hypothesis? As said above, the neuro-scientists interpreted the Sapir-Whorf hypothesis in terms of the lateralization of categorical perception, which, according to that interpretation, should be lateralized in the language (left) hemisphere of the brain. Though this is a perfectly reasonable interpretation of the Sapir-Whorf hypothesis, is it consistent with a weak (trivial) or a strong (non-trivial) interpretation of it?

I shall discuss the weak interpretation after presenting the developmental data but it does seem clear that the lateralization interpretation, though consistent with a non-trivial variety of the Sapir-Whorf hypothesis, may not prove sufficient to validate it. Under the strong hypothesis interpretation, the within-category targets should not have been detected at all. Let us recall the Whorf quotation: perception and discrimination are themselves supposed to be dependent on language. No linguistic category means no discrimination. However, the within-category targets were detected. What is more, English speakers were as good (in fact quicker) as Korean speakers at detecting the across-category targets for which English has no word in the bilingual study. Thus, while the lateralization interpretation is certainly consistent with the non-trivial variety of the Sapir-Whorf hypothesis, it is not sufficient in itself to establish its validation. The non-trivial hypothesis predicts not only lateralization of categorical perception but also no discrimination above and over categorical perception. While the results above do verify lateralization,

they do not verify the absence of discrimination without categorical perception.

Developmental studies

Thus, the adult studies, although they establish the lateralization of categorical perception in the left (language) hemisphere, do not provide any justification for considering that all colour perception is categorical perception and language dependent. Indeed, this is consistent with the WCS results, with the difference between the universality of centroids apparently dependent on the colour perception system and linguistic boundaries between colours (i.e., categorical perception) that display a fair degree of system independence.

The obvious question remains whether there is categorical colour perception before the acquisition of the colour lexicon or whether categorical perception is brought into existence by acquisition. This question was studied in a pioneering study (see Bornstein et al. 1976). It tested categorical perception in 4-month-old infants on the four primary chromatic colours identified by Berlin & Kay in 1969 (blue, green, yellow, red), using a habituation-dishabituation paradigm. The basic idea behind such paradigms is that participants are shown the same stimulus repetitively, until their attention diminishes, indicating *habituation*; then, they are presented with a different stimulus, leading to renewed interest (*dishabituation*). In their study, Bornstein and colleagues presented the infants with a succession of identically coloured screens, and, after habituation, with a differently coloured screen, which belonged either to the same colour category or to another colour category. They found out that infants gaze longer at a new colour from a different category than at a new colour belonging to the same category (as usual, at a constant distance in terms of the colour spectrum). In other words, the infants were capable of categorical perception. This, in itself, seems enough to establish that categorical perception is *not* language dependent as 4-month-olds remain still far from language acquisition.

A further question, given the existence of categorical perception in children, is whether categorical perception is lateralized, and, should this prove the case, whether it is left or right-lateralized. This was tested in another study (see Franklin et al. 2008a). They used a variation on the experimental paradigm used in the adult lateralization studies. Participants were placed in front of a screen in a uniform colour with a fixation cross. The target, a single small circle of a different colour, would appear in any of a range of positions arranged circularly around the fixation cross. It

could be a different colour in the same category as the background or from a different category. Measurement (made through eye tracking) was made of the time between the appearance of the target on the screen and the onset of the participant's eye movement toward the target. Thus, the possibilities were, as above, between the within and across category targets as well as the positioning in the LVF or in the RVF. There were two groups of participants: English speaking adults (mean age 21.8 years) and non-linguistic infants (mean age 20.61 weeks). The results showed, as expected, that, in adults, the asymmetry between the within and across category targets was stronger for RVF presentation. In infants, however, asymmetry between the across and within category targets (the first quicker than the second) was found only when the target was presented in the LVF. This both supports Bornstein's results (i.e., the existence of categorical colour perception in non-linguistic children), and also strongly suggests that categorical perception is lateralized *in the right hemisphere* in pre-linguistic infants.

Thus, categorical perception exists in pre-linguistic infants and is lateralized in the right hemisphere of the brain. In adults, by contrast, it is lateralized in the left hemisphere. This means that a change of lateralization occurs at some point or other in development. A rather obvious question is whether this occurs *as the result* of colour lexicon acquisition.

The same research team (see Franklin et al. 2008b) investigated this further question, applying the same paradigm but with different participants. Children, 2 to 5-year-olds, were divided into two groups: "learners" (mean age: 32 months); and "namers" (mean age: 46 months). To be assigned to the "namers" group, children had to successfully perform two tasks: naming the colour of a swatch, and showing a swatch from a name. The children who failed this dual test were "learners". The two groups were then put through the same experiment as in the previous study. The results indicated that across category targets were detected more quickly than within category targets when presented in the LVF in the "learners" group and when presented in the RVF in the "namers" group. Thus, categorical perception is lateralized in the right hemisphere in the "learners" group and in the left hemisphere in the "namers" group, suggesting that the change of lateralization is, indeed, coupled with the acquisition of the colour lexicon. However, given the difference in mean ages between the two groups, it might also stem from some brain maturation process. Franklin and colleagues reanalyzed their results, controlling for age, and came up with the same results, confirming the right hemisphere lateralization for categorical colour perception in

"learners" and its left lateralization in "namers", and reinforcing the notion that this change is language linked. As stated above, the lateralization data are not enough to verify the non-trivial Sapir-Whorf hypothesis. These further results demonstrate how the best neuro-science can do for the Sapir-Whorf hypothesis is to validate only its weak (trivial) interpretation. However, it might rightly be pointed out that these results cannot be accounted for by the facilitation due to learning, as in the explanation proposed above, thus, weakening the criticism of the hypothesis proposed above. Facilitation is not strong in these studies as there was no failure in detecting the within category targets but, at most, a very slight delay when presented in the RVF (for adults). What is more, the results do show that categorical perception is not itself dependent on language as it exists in pre-linguistic children. Rather, what needs explaining is that change in lateralization, which suggests that categorical perception might be "modified" (accounting for differences in colour boundaries – and, hence, in categorical perception – among adults speaking different languages) by the acquisition of the colour lexicon.

This suggests that the lateralization of discrimination between categories would be particularly important for areas of language and categories subject to categorical perception, i.e., categories that cut boundaries in perceptual continua. In other words, one would expect left lateralization for categorical perception, but not necessarily for discrete categories, corresponding, for instance, to material objects, such as animals.

Lateralization for discrete categories

A study (see Gilbert et al. 2008) investigating precisely the question of the lateralization of discrete categories used black silhouettes of cats and dogs (two of each) in a paradigm similar to that of the lateralization studies of categorical colour perception in adults. In this new detection task, participants were seated in front of a screen with a fixation cross, around which appeared a circle made of black silhouettes, all identical, but for one, the target. The target could be either of the same category or of a different category. Again, participants had to press one of either of two keys to indicate whether the target appeared on the left or on the right side of the circle. There were three conditions: no-interference, verbal interference, non-verbal interference. Interference, in this case, was a memory task. The participants first saw the screen with a fixation cross. Then, they either saw a blank screen (no-interference condition), a screen with a colour word (verbal interference condition), or a screen with a grid