Language Colors Our World: A Summary of the Use of Color in the Study of Linguistic Relativity

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Abstract

Linguistic relativity, a complex and hotly debated topic in the linguistics community, has been controversial since it was spotlighted by Benjamin Lee Whorf in the 1930s. Color is often used as a tool to prove or disprove linguistic determinism; this paper discusses the history of color in the Whorfian hypothesis and in linguistic relativity as a whole and presents and analyzes the findings of particularly important studies, including those by pioneering linguist Benjamin Lee Whorf, Brent Berlin and Paul Kay, and Paul Brown and Eric Lennenberg. Finally, this information will be synthesized to determine to what extent language affects color perception, in the author's opinion.

1 Introduction

Linguistic relativity, a complex and hotly debated topic in the linguistics community, has been controversial since it was spotlighted by Benjamin Lee Whorf in the 1930s. Color is often used to prove or disprove linguistic determinism. Eric Lenneberg and Roger Brown's benchmark study in 1954 used the Munsell color chips to assess Whorf's hypothesis. They theorized that color is both easy to quantify and is part of the human experience - an experience that exists regardless of and independent from the language one speaks. This paper discusses the history of color in the Whorfian hypothesis and in linguistic relativity as a whole and presents and analyzes the findings of particularly important studies, including those by pioneering linguist Benjamin Lee Whorf, Brent Berlin and Paul Kay, and Paul Brown and Eric Lennenberg. Finally, I synthesize the information presented in these studies and attempt to determine with which of the popular hypotheses I agree and to what extent, in my opinion, language affects color perception.

2 Background

The theory of linguistic relativity, that is, the idea that a language somehow affects how its speakers view the world, was popularized in the 1930s by American linguist Benjamin Lee Whorf, a student of Edward Sapir. This theory was dubbed the Sapir-Whorf hypothesis, despite the fact that Sapir and Whorf never wrote any papers together. While Edward Sapir acknowledged a connection between language and worldview, his work sometimes indicates a rejection of the stronger deterministic theory. In his 1946 paper American Indian Grammatical Categories, Sapir writes, "It would be naïve to imagine that any analysis of experience is dependent on patterns expressed in language" (Sapir & Swadesh, 1946, p. 111).

Moreover, the theory of linguistic relativity did not originate with Sapir or Whorf. The concept of a connection between language and thought is an old idea (and consequently, an old debate involving competing positions) traced back to the ancient Greek philosophers. The sophist Gorgias of Leontini claimed that the world could not be experienced except through language (Higgins), while Plato argued that the world is made up of eternal ideas, and language is merely a reflection of those ideas (Demos, 1964). The German Romantic philosophers would further explore this idea of a connection between language and thought in the 18th and 19th centuries. Wilhelm von Humboldt would claim that language and thought must be irrevocably intertwined since thoughts cannot be produced without language; that is, thoughts are produced as an internal dialogue in the

speaker's native language and grammar, and one cannot exist without the other. He also believed that language produces an individual's worldview through its particular grammatical constructions, such as its syntactic models and its lexical categories, and then went further to say that since cultures are made up of individuals who speak the same language, then a language must encapsulate the worldview of an entire culture (Kahane & Kahane, 1983). Franz Boas, American anthropologist, ethnographer, and Edward Sapir's teacher, imported this German idea of *Völkerpsychologie*, or the psychology behind cultural products such as language, religion, and mythology, to the United States in the early 20th century.

Over the past century, this ongoing linguistic debate has largely taken two forms: the strong hypothesis and the weak hypothesis. The strong hypothesis, also called linguistic determinism, states that a language determines how its speakers see the world. First proposed by Whorf in his paper *Science and Linguistics*, published in 1940, it was widely accepted before being rejected just as quickly in light of arguments against it proposed in the 1950s and 1960s when American linguist and father of modern linguistics Noam Chomsky spotlighted the universality of human language and cognition in his theory of universal grammar.

The weak hypothesis, a far more popular theory at the time the paper was written, takes a far less decisive stance and claims that while language does influence the way that its speakers see the world, it is by no means exhaustively determinative. Other cultural factors must be considered, as must the restraints imposed by human biology.

Both of these theories are difficult to definitively prove or disprove for many reasons. First, it is impossible to see the world through the eyes of another human being. Second, it is impossible (or at least extremely difficult) to understand how a language affects worldview if one is not a native speaker of that language. The task of deriving a study that would prove or disprove Whorf's hypothesis was difficult. Given these challenges, it was necessary to find something that was a fundamental part of human existence and could represent worldview but was also easy to measure and quantify.

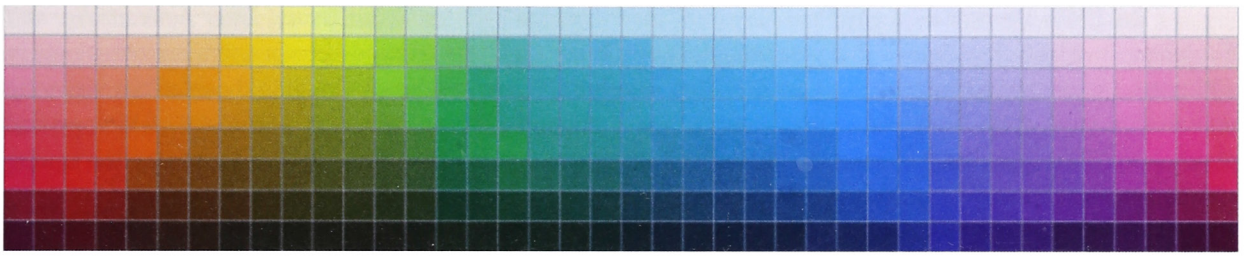

Figure 1: 330 color swatches from the Munsell color system (Jraissati & Douven, 2018). Note how hue changes on the x-axis and value changes on the y-axis.

Researchers could use Munsell color chips, swatches of color classified based on their hue, chroma, and value, as an independent variable, and speakers of different languages as their dependent variable in an attempt to determine if the language a person speaks affects the way they perceive and recall the color swatches presented to them. Thus, color was the obvious choice.

3 Previous studies

The first study to be examined is Whorf's foundational essay *Science and Linguistics*, published in 1940. This study had little to do with color, and more to do with kickstarting the discussion and debate surrounding linguistic relativity in the 20th century. In this essay, Whorf claimed that speakers of different languages were cognitively different from one another and that he had discovered a "new principle of relativity, which holds that all observers are not led by the same physical evidence to the same picture of the universe unless their linguistic backgrounds are similar" (Whorf, 1940, p. 7). He claimed he could prove his conjecture via examination of Hopi, a Uto-Aztecan language spoken in northeastern Arizona. The Hopi language, claimed Whorf, has no concept of time whatsoever. It has no word to describe the noun "time," and no grammatical constructions to indicate the past or future. Since their language was supposedly void of any concept of time, Whorf concluded that the Hopi people could not conceive of time in the same way a speaker of a language like French, English, or German (languages that Whorf categorized as "standard average European," or "SAE,") does. The Hopi people must experience reality in a totally different, timeless way.

This theory captured the minds of linguists from its publication onward. The idea that there may be as many different worldviews as there are languages spoken was an intriguing one and attempts to prove or disprove it came shortly after the essay's publication.

One of the first studies to employ color as a means of studying the way that language affects general worldview was undertaken in 1953 by Eric Lenneberg. In his paper *The Denotata of Color Terms*, he examined speakers of the Zuni language, a language isolate spoken in New Mexico and Arizona. Zuni has only one word to refer to the colors that English speakers refer to as yellow and orange. Lenneberg tested color recall in his subjects by "[Showing the subjects] some colors for a second and then, after half a minute, they were required to pick out the colors they had been shown from a large chart containing 250 colors, systematically arranged" (Lenneberg, 1955). Zuni speakers had great difficulty recalling and naming the colors that English speakers call yellow and orange. Lenneberg credits this difficulty to linguistic codability, or whether it is difficult or not to name an object. Since English speakers have terms to distinguish yellow and orange, it is easy for them to put a name to the difference between the two colors. However, in a language without that linguistic distinction, it is impossible to describe the difference one sees between yellow and orange, even if the subject is visually aware of it. This study would also begin a tradition of investigating linguistic relativity through color terminology.

Eric Lenneberg would later team up with Robert Brown to write the 1954 paper *A Study in Language and Cognition*, where they further explored the consequences of linguistic codability on color recall, this time testing English speakers in a similar manner to the Zuni speakers in Lenneberg's 1953 study. Their findings confirmed that the presence of a basic color term in a language directly affects the retention of the color in the memory recall test. If English had a clear color term for the color the speakers were to recall, the recollection came easily. But if the color the speakers were to name had no clear color term in English, naming it became far more difficult, proving that the presence or absence of a color term in a language affects, at the very least, the speaker's ability to discuss that term.

In 1969, Brent Berlin and Paul Kay published their book *Basic Color Terms: Their Universality and Evolution*, in which they argued that perception of color is not, in fact, a cultural phenomenon, but one innate in all humans regardless of language and culture. This introduced a new counterargument to the relativist view: the universalist view. This view states that color is not a cultural phenomenon, but a product of biology and psychology. They claimed that since the biology of all human beings is the same, that color perception among all humans must thereby be universally constrained.

Berlin and Kay's study found that there is a restriction on the number of basic color terms, or BCTs, that a language can have – the maximum number is eleven color terms, (though some argue that Russian has a twelfth term.) Basic color terms must be monolexic (e.g., "green," not "yellow-green"), and monomorphemic (e.g., not "greenish"). Their significations must not be included in another color term (e.g., not "emerald"), and their use must not be restricted to a certain class of objects (e.g., "brunette" can only describe brown hair.) Finally, they must be psychologically salient for all speakers (e.g., not "the color of the tablecloth we use at Easter") (Berlin & Kay, 1969).

They also claimed that there is an order in which colors appear in a language. Their findings were as follows:

1.) Every language has at least two BCTs: black and white, or, alternately, light and dark.

2.) If a language has a third color term, it will be red.

3.) If a language has a fourth color term, it will be either green or yellow, in no particular order.

4.) If a language has a fifth color term, it will be either green or yellow; whichever of those it is missing.

5.) If a language has a sixth color term, it will be blue.

6.) If a language has a seventh color term, it will be brown.

7.) If a language has eight or more color terms, they will be purple, pink, orange, or gray, in no particular order. (Berlin & Kay, 1969).

Finally, and perhaps most importantly, they found that BCTs in all languages respond to very similar shades of Munsell color chips, which indicates that the perception of these BCTs is roughly the same cross-linguistically.

Berlin and Kay's study effectively tore down the argument that color perception (and with it, worldview) varies wildly cross-linguistically. If color perception had indeed varied as Whorf had predicted it would, then basic color terms likely would not exist at all, as the diversity of worldviews would not lend themselves to having such uniform and consistent terms.

Later universalist studies include one from 1976 by Kessen, Bornstein, and Weiskopf, in which they exposed four-month-old infants to different frequencies of light that corresponded to different colors. In their subsequent paper *Color vision and hue categorization in young human infants*, the researchers noted that the length of habituation, or the decrease of a response to a stimulus due to repeated interaction with said stimulus, was longer when the infants were exposed to different hues surrounding a focal color (e.g., different shades of green) than when they were exposed to several focal colors (green, blue, yellow, etc.) in succession (Bornstein & Kessen & Weiskopf, 1976). This was strong evidence to confirm Berlin and Kay's hypothesis that color is innate and not a product of a worldview produced by language, as these infants had not yet acquired language, yet they still responded in the way that adults do to different hues and focal colors. Thus, Kessen, Bornstein, and Weiskopf were able to argue that the ability to perceive focal colors is an ability present even in babies who have no language to shape the way they view the world. At the very least, color (and consequently worldview) cannot be determined *solely* by language.

Berlin and Kay's study would be criticized by Barbara Saunders in her 2000 paper *Revisiting Basic Color Terms*, in which she claims that Berlin and Kay make several assumptions that diminish the quality of their research, including an ethnocentric bias towards Western philosophy and scientific thought, and poor, over-generalized translations of basic color terms from other languages (Saunders, 2000). She also criticized the general use of Munsell color chips and their effectiveness in the recall of color terminology and identification of focal hues, as she believes that the use of the Munsell color system is an example of one of social research's most common follies: the assumption that the real world and its nuances can somehow be replicated in data sets. The way humans perceive colors in the world cannot be distilled to a color system that fits neatly on a page, researchers cannot accurately gauge to what degree language affects a speaker's worldview, and perception of color cannot be determined in a lab. The way that humans naturally discuss color must be examined in the context of the wider world, not a set of colored cards.

4 Discussion

Therefore, which theory is correct? It is not as simple as proclaiming that one idea is entirely right or entirely wrong. Whorf's wholesale idea that language must be the sole thing that influences the way that humans see the world is inherently flawed, but so is the idea that human biology is the only thing that influences color perception.

Whorf's hypothesis, though fascinating to consider, can be disproven. First, it does not account for translatability. If every language encoded a completely different worldview and reality, it would be impossible to translate one language to another, yet this is something that human beings do daily. Second, Whorf's argument was centered around the Hopi language and its supposed lack of concept of time, but in his 1983 book *Hopi Time: A Linguistic Analysis of the Temporal Concepts in the Hopi Language*, Ekkehart Malotki successfully refuted the belief that Hopi has no concept of time. The Hopi language does, in fact, have many words and grammatical constructions for temporal relations, but unlike English, which differentiates between past and non-past, Hopi differentiates between future and non-future (Malotki, 1983). This discovery was a devastating blow to Whorf's theory.

Linguists generally agree that a deterministic approach to linguistic relativity is wrong, and I agree. The evidence presented by Lenneberg and Brown, Berlin and Kay, Kessen, Bornstein, and Weiskopf, and Malotki is overwhelming.

I believe that Lenneberg's 1953 study, followed by Lenneberg and Brown's 1954 study, explains the conundrum of perceived differences in worldviews caused by linguistic codablity. They prove that linguistic codability can create the illusion of a difference in visual perception and worldview, where in reality, there is not one: speakers of Zuni are aware that there is a difference between the terms English speakers call yellow and orange. They are able to visually perceive said difference. However, since yellow and orange both fall under one

basic color term in Zuni, they are not able to name the two distinct colors. Lacking a name for something is not the same as lacking the ability to perceive and understand something.

Berlin and Kay's study strongly influenced my personal beliefs surrounding linguistic relativity. They attempt to prove the weak hypothesis by proposing that there are minor differences in color perception, but that overall, human beings will perceive the same colors due to the constraints of biology. If Whorf's hypothesis were true, they would not have found any consistent BCTs across languages, never mind being able to discern a pattern in which they appear.

Barbara Saunders' criticism, especially regarding the use of the Munsell color system as a tool for researching the way that language influences color perception, is unfounded. While it is true that much social research would best be done in a "natural" environment, that is not always an option due to time constraints, the ability to control variables, and the reliability of subjects. Perhaps color perception *would* best be tested outside the context of a formal study, but as of the time this paper was written, nobody had crafted a way to do that while simultaneously maintaining the study's efficiency and credibility.

I tend to agree with Paul Kay and Terry Regier in their paper *Language, thought, and color: Whorf was half right*, in which they claimed, "[t]here are universal constraints on color naming, but at the same time, differences in color naming across languages cause differences in color cognition and/or perception" (Regier & Kay, 2009, p. 6). Color is simultaneously influenced by culture and language and constrained by human physiology. Save for those who are visually impaired, every human is able to perceive the same colors. Every human can see all eleven of Berlin and Kay's basic color terms, and a person from a culture that only has three words for color would still be able to see colors that they cannot name, such as green or purple. They would simply have difficulty describing them using a basic color term and may instead resort to using non-salient terms such as "the color of grass in spring" or "the color of my favorite shirt."

Another supposed variation comes in the nuances for names of different hues of the same basic color terms, like crimson, emerald, and lilac. There may be slight variations in the ways that different linguistic groups perceive color that can be accredited to cultural or linguistic differences (e.g., a tribe living in the Amazon may be able to perceive and name slight differences in different shades of green more efficiently than someone who lives in downtown Berlin.) Color perception also can vary minimally among different groups in the same culture (e.g., a painter may perceive and name more variation in hues, and would call something "robin's egg blue," than a lawyer, who may call the same swatch "light blue") due to the nature of the environments in which they live and work. However, these variations are minimal and do not constitute massive shifts of worldview. Every human sees basically the same colors regardless of the language they speak or the culture from which they come.

In linguistics, as in most fields, while theories and hypotheses fall in and out of favor, they essentially operate constructively, building on one another as more data is collected and analyzed. Linguistic relativity is a complicated issue with rich literature and seemingly innumerable studies that are constantly being lauded by the linguistics community, and then just as quickly criticized or disproved as linguistics advances as a discipline and more knowledge is added to the pool. While it is generally agreed upon these days that the strong hypothesis and linguistic determinism are not effective ways to describe the way that language and worldview are intertwined, such a view was once widely accepted, and it is wholly possible that the current idea that language and thought influence each other will soon go out of style in favor of a new idea proven by a paper yet to be written.

The weak hypothesis should be further explored to determine the extent to which one's culture affects color perception, versus the extent to which biology affects color perception. To determine the effect of culture, I suggest a study using Munsell color chips to compare the perception of people who live in a large city with people who live relatively isolated in nature – perhaps the city people will be able to remember a larger variety of BCTs, while the people living in the Amazon will categorize fewer BCTs, but will be able to perceive slight differences in the hue of a single, important BCT.

The extent to which one's place within a particular culture (sex and gender roles, jobs, etc.) affects color perception should also be researched further. With regard to sex, it is believed that women differentiate between more colors than men, particularly in the green-blue region (Fider & Komarova, 2019), and according to Leonard Sax in his book *Why Gender Matters, Second Edition: What Parents and Teachers Need to Know About the Emerging Science of Sex*, that is tied to the fact that the structure of the eye in men and women is

actually different: women are more sensitive the color changes, while men are more attuned to movement (Sax, 2017). Men and women are biologically wired to perceive the world differently. So to what degree does biology influence the way we see color, and how does that manifest in the way men and women use language to describe their surroundings? Does increased color perception have to do with biology alone, or does it also have to do with gender roles imposed on men and women by society? If an increase in the ability to name colors only ever appears in women, and not in men who take on traditionally "feminine" roles, such as a primary caretaker to children, or men in color-heavy careers, such as artists or interior decorators, then nuances in color perception are (at least primarily) biological, and have little to do with imposed gender roles. If, however, it turns out that despite the differences in the male and female eye, nuanced color perception does appear in men who take on traditionally "feminine" roles, then we can assume that some aspect of color perception is learned.

5 Conclusion

In conclusion, I believe that language and perception are locked in a give-and-take situation. Language, culture, and biology are all factors that influence one another, and so all of them consequently influence worldview. Most humans experience the visual element of color in generally the same way due to our identical biology, but with slight nuances owing to our varying cultures and the roles and places we occupy within them.

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