CHARLES UNIVERSITY IN PRAGUE

Faculty of Humanities

Color Acquisition in Slovak Preschool Children

Bachelor's Thesis

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Prague 2010

AFFIRMATION

Hereby, I declare that this dissertation is a result of my own work and I have stated all used information sources. I approve publishing of this work by Charles University in either electronic or print version.

Prague, 28th May 2010 ....

signature

ČESTNÉ PROHLÁŠENÍ

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V Praze dne 28. 5. 2010 ....

podpis

ACKNOWLEDGEMENTS

Most of all I would like to thank my supervisor, Irma Hvorecká, Ph.D. for her invaluable guidance and encouragement.

My thanks also go to Jarmila Beliková, Miriam Mošaťová and Viera Házašová, headmistresses of the day care centers, for their readiness to help with anything I needed. I am grateful to all the teachers in the day care centers for their assistance and patience. But my biggest thanks go to all those sweet little children who participated in my research.

I am especially grateful to my partner Peter, my father and mother for their love and support. This work would not have been possible without them.

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1 INTRODUCTION

When we watch the blue sky on a sunny day or a rainbow after rain, rarely do we realize how complicated is the process that goes through our body and mind and allows us to admire colors.

The phenomenon of color has been puzzling scientific minds for centuries and yet a lot of questions are waiting to be answered. Therefore I decided to investigate one aspect of this phenomenon and focus my study on color knowledge in children, on how they perceive and name color sensations and factors that influence the acquisition of color.

In the forepart of this study I present definitions of color, color vision, color perception, color naming and the description of two rival theories on the relation between language and thought, relativism and universalism. I will proceed further with the description of my own empirical research which deals with acquisition of color in Slovak preschool children. There I focus on the aspects underlying their color knowledge and try to establish the role of perception and language in children color acquisition.

2 RELATIVISTS VERSUS UNIVERSALISTS

2.1 SAPIR – WHORF HYPOTHESIS

The idea of linguistic relativity originated in 19th Century Germany and can be ascribed to anthropologist Franz Boas, although similar theories originated previously (Kay & Kempton, 1984) In the 20th century this idea was elaborated upon by Boas's student Edward Sapir, and Sapir's student Benjamin Lee Whorf, and therefore is often referred to as Sapir – Whorf Hypothesis.

Sapir's conservative version of the idea of linguistic relativity states that language influences our thinking and the way we perceive reality as human thoughts are always formulated in a particular language. Sapir believed that the linguistic structure of one's native language influences the world view that he[1] will acquire as he learns the language (Brown 1976, cited in Kay & Kempton, 1984:66). Linguistic structures thus create a specific vision of reality for each language community.

Benjamin Lee Whorf radicalized the hypothesis of his teacher and claimed that language is not only a tool that shapes our thoughts, but a force which actively forms them. This extreme version of linguistic relativity states that the way we experience the world is determined by the language we speak. In his words: "The world is presented in a kaleidoscope flux of impressions which has to be organized by our minds – and this means largely by the linguistic systems of our minds" (Whorf, 1956 cited in Linguistic relativity, 2001).

The principle of linguistic relativity thus denies in certain extreme cases the possibility of perfect translation between two languages or complete comprehension between members of different language communities.

Sapir and Whorf inspired a number of scientists from various fields – linguistics, anthropology, anthropological linguistics, psycholinguistics and many others - to test

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[1] 'he' is in the whole text used as a generic pronoun which refers to an unspecified person of any gender

their hypothesis in empirical research (Johnson, 1977; Kay & Kempton, 1984; Davies et al. 1994, 1998; among others). Although neither Sapir nor Whorf ever wrote on color (Kay, Maffi, 2000), it seems to have become a popular semantic category in works focused on the relationship between language and thought. Studies on color were published by followers of the relativist branch like Saunders (2006) or Wierzbicka (2006) but also by scientists who had a different point of view on the matter.

2.2 BERLIN AND KAY'S BASIC COLOR TERMS

Opposed to relativists, there are scientists who believe that there exist so-called semantic universals, semantic categories shared by all humans. Universalists believe that semantic universals are innate, grounded in our biological nature, and thus common to all people no matter which language they speak or what culture they come from. According to them, color is one of these semantic universals.

In 1969, Brent Berlin and Paul Kay carried out research which intended to prove the existence of semantic universals and thus discredit the doctrine of extreme linguistic relativity. Their hypothesis was based on the observation that names of colors translate too easily among various pairs of unrelated languages for the extreme linguistic relativity thesis to be valid. Berlin and Kay (1969) doubted the commonly held belief that each language segments the color continuum arbitrarily and independently of other languages. Not only did their study prove a total universal inventory of exactly eleven basic color categories (white, black, red, yellow, green, blue, brown, pink, purple, orange and gray) but they also found an evolutionary order in which these eleven basic color terms appear among languages. Berlin and Kay (1969) defined a basic color term as:

1. Monolexemic – its meaning is not predictable from the meaning of its parts (excluding, for example *lemon-colored*).

2. Its signification is not included in that of any other color term (excluding, for example *scarlet* which is a kind of red).

3. Its application must not be restricted to a narrow class of objects (excluding, for example *blonde* which is restricted to hair).

4. It must be psychologically salient for informants (for example, it must occur at the beginning of elicited list of color names).

The Berlin and Kay study operated mainly with focal hues of colors, as color boundaries were difficult to determine. At first, participants were asked to elicit basic color terms of the language in question; second, they had to place foci and boundaries of listed colors on the color spectrum. Results showed that foci of basic color terms are similar in all tested languages. What is even more, the location of color foci varies slightly more between speakers of the same language than between speakers of different languages.

Results of this experiment indicated that color categorization is not random, and foci of basic color categories are very similar amongst all languages. These finding suggest that our perception of color categories is constrained by the physiology of our visual system, which is common to all people regardless of the language they speak (Bonnardel & Pitchford, 2006).

An unexpected finding of this study was that there are certain principles according to which basic color terms appear in languages. They are as follows: every language has labels for black and white (dark and light). If a language has three color terms then it has name for red. Next comes either yellow or green, which is followed by the remaining color from this pair. If a language contains six color terms then it has a name for blue. Blue is followed by brown. Lastly, if a language includes eight or more color terms then it has a term for pink, purple, orange or gray or some combination of these (Berlin & Kay, 1969). These principles can be recapitulated by a simple rule:

$$\begin{bmatrix} \text{white} \\ \text{black} \end{bmatrix} < [\text{red}] < \begin{bmatrix} \text{green} \\ \text{yellow} \end{bmatrix} < [\text{blue}] < [\text{brown}] < \begin{bmatrix} \text{pink} \\ \text{purple} \\ \text{orange} \\ \text{grey} \end{bmatrix}$$

Simply put, if a language has a name for one of these colors, it must have terms for all colors that precede it in this hierarchy.

Berlin and Kay (1969) transformed this sequence of color terms into seven evolutionary stages:

Stage I. Stage II. Stage III. Stage IV. Stage V. Stage VI. Stage VII.

$$\begin{bmatrix} \text{white} \\ \text{black} \end{bmatrix} \rightarrow [\text{red}] \prec \begin{matrix} [\text{green}] \rightarrow [\text{yellow}] \\ [\text{yellow}] \rightarrow [\text{green}] \end{matrix} \succ [\text{blue}] \rightarrow [\text{brown}] \rightarrow \begin{bmatrix} \text{pink} \\ \text{purple} \\ \text{orange} \\ \text{grey} \end{bmatrix}$$

They believed that these evolutionary stages reflect the technological and cultural development of nations.

Further extensions and revisions by Berlin, Kay, Maffi (Kay & Maffi, 2000), McDaniel and Merrifield were applied to the theory over the years. Even the most recent versions predict that the first six color terms, or so called “primary” color terms (white, black, red, yellow, green, blue), should be acquired earlier than the remaining “secondary” color terms (brown, pink, purple, orange, gray). Primary color terms denote the primary color categories, which are considered perceptually unique and cannot be analyzed in terms of any other color combination. Secondary color categories, which are labeled by secondary color terms, can be described by using a combination of the six primary terms (Pitchford and Mullen, 2006).

3 COLOR

3.1 WHAT IS COLOR?

Color is a feature of light. Light visible to the human eye is electromagnetic energy, which falls in the range of wavelengths between 400 and 700 nanometers (Bornstein, 2006). Although pure white light is perceived as colorless, it actually contains all colors of the visible spectrum. Differences in received wavelengths are perceived by humans as different colors of spectrum. When light hits an object, some colors are absorbed and others are reflected. Only reflected colors contribute to our perception of color (McHugh, 2005).

Color varies along three dimensions – hue, saturation and brightness. Hue plays the central role in color vision; only due to hues do we perceive qualitative differences among colors (Bornstein, 2006). Colors consist of a whole range of wavelengths, hue describes which wavelength appears to be the most dominant (McHugh, 2005).

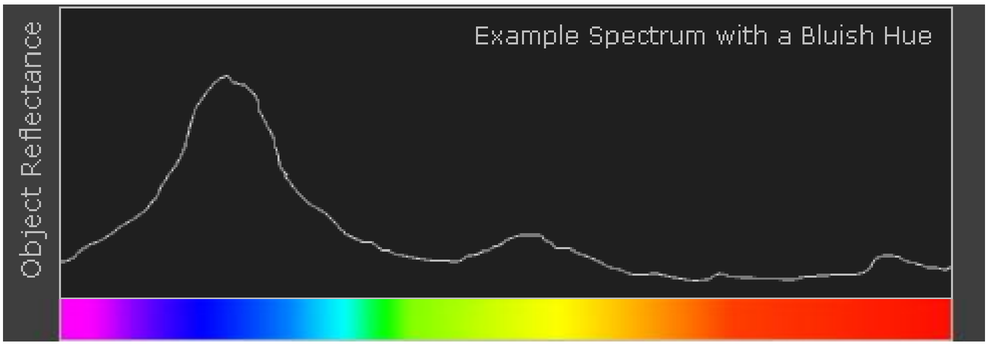

Figure 1: Example spectrum with a bluish hue[2].

Although most colors contain a hue, there are colors such as black, white and gray that are called achromatic and do not have a hue. Chromatic colors denote those with hue, such as red, green, blue, yellow etc.

[2] Figure 1 was taken from McHugh (2005).

Saturation is the term which defines the intensity of hue within a given color. The more saturated colors are, the more vivid are their hues; lower saturation brings colors closer to gray and makes them look more pastel-like (Foley, 1997).

Figure 2: Red hue with medium degree of brightness ranging from maximum to minimum saturation (from left to right).

Finally, brightness is a measure of the amount of light reflected by a color. It can vary from pitch black to a barely visible white.

Figure 3: Red hue with maximum degree of saturation ranging from minimum to maximum brightness (from left to right).

PHYSIOLOGY OF COLOR VISION

The physiology of human vision is consistent among all members of the genus Homo[3] (Foley, 1997). The human eye senses the visible spectrum using two types of photoreceptors [4]– rod and cone cells. Rods are only sensitive to the intensity of light and do not contribute to hue discrimination whereas cones facilitate color vision and

[3] except for those with vision disorders

[4] Photoreceptor- light-sensitive receptive cells on the retina of human eye which absorb photons, the particles of light (Rebrová, 2009)

function best in bright light. The peak sensitivity of rod cells to light is at approximately 510 nm[5] which refers to the green-blue part of visible spectrum. Cone cells are most sensitive to the yellow-green region of the spectrum that is around 555 nm.

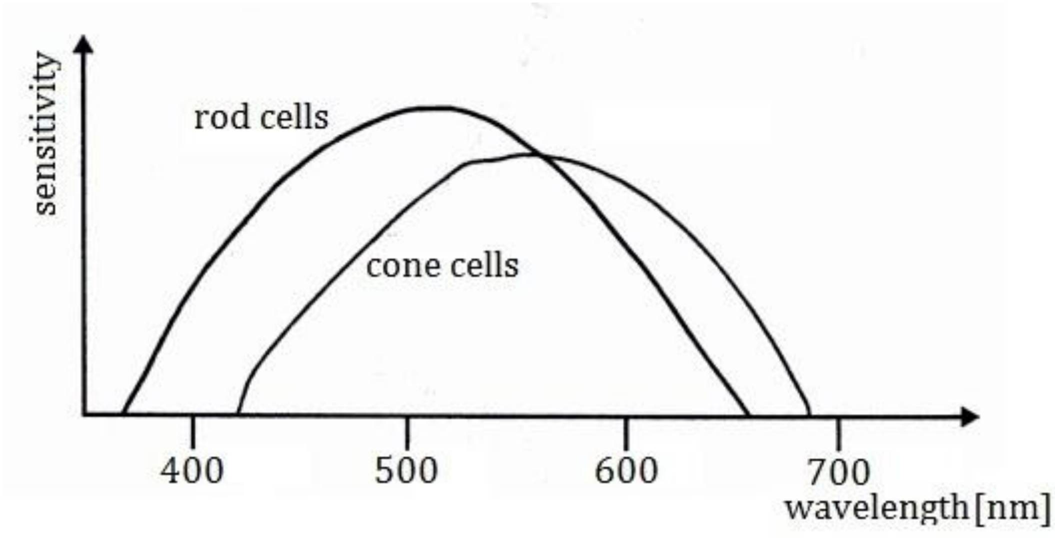

Figure 4: Maximum sensitivity of rod and cone cells

There are two theories on how human color vision works. The trichromatic theory, described in Bornstein (2006), proposed by Thomas Young and Hermann von Helmholz, states that there are three types of color receptors – cone cells on the retina, each with a different sensitivity to light. One is receptive to light of short wavelengths (blue), one to middle wavelengths (green) and the third type of retinal receptors is sensitive to long wavelengths (red). The combinations of these three mechanisms enable us to perceive all colors of spectrum. (Bornstein, 2006)

A different view on the matter was offered by Ewald Hering in his opponent-process theory, as explained by Foley (1997). Hering claims that the human visual system consists of three subsystems which interpret color in a mutually antagonistic way. The first subsystem is achromatic and indicates differences in brightness (white-black); the other two signal differences in hue (red-green, yellow-blue). These two

5 Nanometer – unit of the wavelength of light

chromatic subsystems are made up of oppositions; one pole always excludes the other. For instance, an increase in blue causes a decrease in yellow. When we perceive one of the “pure” hues (red, green, yellow or blue) one of the subsystems is set on particular color and the remaining pair is neutral. White or black can be perceived when both chromatic subsystems are on a neutral setting and only the achromatic subsystem is active. On the other hand, “mixed” colors (brown, pink, purple, orange, gray or any others) are the outcome of cooperation of both chromatic subsystems. For example, when we perceive the color known as orange, the red-green subsystem signals red, while blue-yellow subsystem indicates yellow.

However, most scientists believe that color vision can be explained as a combination of trichromacy and opponency, in a so-called *zone theory*. At the photoreceptor level, the spectral composition of light is analyzed by the three cone photoreceptor classes (blue, green, red) with different absorption spectra as suggested by the trichromacy theory (Bornstein, 2006). From there, information proceeds through horizontal and bipolar cells into the inner retina. There, received signals are recombined into three antagonistic opponent channels (white-black, red-green, blue-yellow) as explained by the opponent-process theory. The outputs from the inner retina are carried to the visual cortex on anatomically separate pathways (Bornstein, 2006).

This kind of explanation of color vision could clarify why the primary colors (white, black, red, yellow, green and blue) are listed in the first stages of Berlin and Kay’s evolutionary sequence of basic color terms. According to the color vision theories, the perception of primary colors is less demanding than the perception of secondary colors (brown, pink, purple, orange, gray).

3.2 COLOR PERCEPTION

It is important to emphasize that color is not a feature of objects. Our world consists of colorless matter which has the ability to absorb or reflect electromagnetic wavelengths. Retinas translate received wavelengths into neural impulses and send them via visual pathways to the brain where they *need to be processed*. Only then do we truly perceive the sensation of color (Plháková, 2005). Perception is a process of understanding sensory information. What happens with the information that the brain receives from the visual system? Philosophers and psychologists have been deliberating for ages and have come up with a countless number of theories on human perception (Plháková, 2005). Today's science is still far away from solving this riddle but one thing is certain: to truly perceive the endless amount of information that enter our minds we need to *categorize it.*

Categorization is a central adaptive system of perception, cognition and language. It refers to a many-to-one psychological reduction of physical stimulation based on perceived similarities (Bornstein, 2006).

In case of color, categorization means the division of physical continuum of wavelengths into a finite number of categories based on the perceived qualitative similarity of hue among them (Bonnardel,& Pitchford, 2006). "Hues are then *similarity categories,* groupings of non – identical wavelengths many of which may be perceptually discriminable or indiscriminable from one another but still treated as similar" (Bornstein, 2006: 43).

According to Bornstein (2006) perceptual color categories are structured on three different levels – superordinate, basic and subordinate [6] . Categories on the superordinate level are based on attributes common to all its members, in our case it is "*color*". Basic categories consist of different qualities of categories on the superordinate level; for color it is *red, yellow, green* and *blue*. Lastly, subordinate categories are different shades or tones of a given basic color category; for instance *cherry, crimson, scarlet* are all inferior to the basic category of red. It should be noticed that basic color categories recapitulate "pure" hues recognized in color vision physiology and with addition of the achromatic pair – white and black, correspond to Berlin and Kay's primary colors. That is probably due to their foundation in the biological functioning of the visual system.

Color categories range from focal hues (the best example of hue with no additional wavelengths of other hues) all the way to boundary hues which border with adjacent hues. Focal hues are categorized faster and easier than boundary hues.

[6] This tripartite taxonomy applies also to categorization in general.

According to Davidoff (2006), Bornstein (2006) and many others, categorical perception[7] (demonstration of within category similarity and between category dissimilarity) goes hand in hand with the possession of *color concept*. The ability to represent color conceptually means to regard it as a property that can be thought of independently of the objects that posses it (Kowalski & Zimiles, 2006).

3.3 COLOR NAMING

The same wavelength of light can produce different color sensation under different viewing conditions; the only way to tell which color a person sees is to ask for the name. Color terms do not denote separate wavelengths but perceptional categories, groups of wavelengths. Humans perceive many more differences in hue than they can name. There is a reason to believe that the three fundamental oppositions of the visual system black-white, red-green and yellow-blue are reflected in the color terminology of many of the world's languages. (Miller & Johnson-Laird, 1976)

Research carried out by Boynton and Gordon in 1965 (Bornstein, 2006) examined the ability of English speaking participants to name presented wavelengths using only four primary color terms (red, yellow, green, blue). Subjects were asked to use no more than two of these terms to describe the perceived sensation. Results showed that in English and perhaps also in other similar languages, the four primary hues are sufficient to describe all colors of chromatic spectrum.

[7] Especially on the superordinate level.

4 CHILDREN AND COLOR

4.1 INFANT COLOR VISION AND CATEGORIZATION

According to Bornstein (2006) newborn children are capable of some limited color vision. Most newborns can discriminate red from achromatic background but not blue, yellow and green. Approximately three months after birth, infants posses all the retinal components necessary for adult-like color vision. Around the age of three to four months they can discriminate all four basic hues from white background, with blue being the slowest to develop. Experiments have proved that soon after children see color, they are able to nonverbally treat wavelengths as similar or different. And so, long before children acquire color terms they have the ability to categorize basic hues into categories similar to those of adults.

Opinions on how humans acquire color divide into two directions. Both sides admit that color acquisition derives from conceptual knowledge and lexical knowledge, they just cannot decide which one precedes which (Sandhofer & Thom, 2006). On one side, relativists claim that acquisition of color terms precedes categorical perception although they are closely linked in time (Sandhofer & Thom, 2006). On the other side, universalists believe that colors first need to be categorically perceived and conceptualized and only then can they be labeled with color terms. Empirical research was carried out on both sides to prove either a biological or linguistic basis of color acquisition, but diversity of methodology caused notable differences in results so the question remains unanswered.

4.2 COLOR TERMS IN CHILD LANGUAGE

Appropriate usage of color terminology requires the referential mapping of color terms to color perceptions. But before children are capable of such mapping a considerable preliminary learning must take place, which probably is the reason for late onset of color term acquisition. Color terms appear relatively late in children language acquisition compared to how early in life they are capable of color categorization. According to Pitchford and Mullen, there are two distinct time periods in which children acquire basic color terms. From 36 to 40 months they learn to use nine basic color terms correctly (black, white, red, green, yellow, blue, pink, orange and purple) and the remaining two (gray and brown) are acquired around the age of 46 to 49 months (Pitchford & Mullen, 2006).

According to Miller and Johnson-Laird (1976) the learning process involves two aspects, conceptual and linguistic. The conceptual aspect consists of three tasks. First, a child must make an appropriate abstraction of color from other attributes of visual experience such as size, shape, texture, temperature and weight. Next, children need to acquire primary colors[18] (white, black, red, yellow, green, blue) which are more perceptually salient compared to other colors. Lastly, a child must learn to use primary colors as a stable frame of reference for all colors of spectrum. Along with the conceptual aspect, a child must develop the linguistic aspect of color term acquisition. First, it is necessary to associate color terms with particular objects or contexts. For instance, even without consciously referring to color, children use phrases like “white as snow” or “green grass”. Although color words are included in such expressions, they don’t seem to have any particular color reference for children. At this point of color term acquisition, a child has not yet learned that color words belong together in a single semantic category. When this step is accomplished, children must learn to isolate color terms from other words as a contrastive set. They have to relate color terms to each other and learn that color words are contrasting hyponyms of “color”. In the final stage of color term acquisition, children learn to apply referential terms on appropriate color sensations. In other words, a child must

[8] Miller and Johnson-Laird use term “landmark colors” as equivalent to Berlin and Kay’s primary colors.

learn what color each term refers to. Once this process begins, with the first acquired term, the remaining colors come in one at a time and add on relatively fast.

5 COLOR ACQUISITION IN SLOVAK PRESCHOOL CHILDREN

5.1 INTRODUCTION

A great amount of empirical research has been carried out in the field of color terminology (Johnson, 1977; Pitchford & Mullen 2005, 2006 among others); nevertheless only very few seem to tackle this issue with concern for Slovak language (Rebrová, 2009) and there aren't any known works that focus on color terminology acquisition in Slovak children. In this study I try to fill this gap and examine both perceptual and linguistic acquisition of colors in Slovak preschool children.

The main aim of this study is to try to establish a developmental order of perceptual categories as well as color terms in Slovak preschool children.

The first hypothesis is that primary colors of white, black, red, yellow, green and blue will appear at the beginning of both developmental sequences, leaving secondary colors of brown, pink, purple, orange and gray behind. In case of perception such expectation is based on the results from previous studies that confirmed infant ability to categorize primary hues as early as four months of age and significant role of primary colors in color categorization (see sections on Color categorization). As for color naming, primary color terms should appear among first on the developmental scale for they serve as a frame of reference for all other colors of spectrum in both adult and child language (Miller & Johnson-Laird, 1976). Such results would indicate a biological predisposition for color sensitivity.

Second hypothesis states that there will be a significant similarity in developmental order of perceptual categories and color terminology. In other words, color categories appear in certain developmental order; this order is then recapitulated in acquisition of color terms. Such finding would support the universalistic claim that children first have to learn to distinguish color categories through the process of categorical perception which is proved to have biological foundations (see section on Color) and only then they label these categories with color terms. Therefore it could be claimed that acquisition of color terms has roots in the physiology of human visual system.

My *research question would be whether developmental sequences of color terminology resemble the evolutionary order proposed by Berlin and Kay (1969).* Investigations by Johnson (1977) and Pitchford & Mullen (2006) reported ambiguous findings on this issue. Johnson's (1977) results show the developmental order of color terminology of English speaking children in relation to their age as follows: *red, green, black, white, orange, yellow, blue, pink, brown,* and *purple*[9]. Berlin and Kay's evolutionary sequence is not apparent in Johnson's outcome although with the deletion of orange, whose early appearance is caused by the fact that term "orange" in English denotes both color and fruit, we can confirm the advantage of primary colors over secondary.

Different results were achieved by Pitchford and Mullen (2006) in their experiment designated to test color comprehension and production in English children. The results do not show any significant advantage of primary over secondary colors. Instead their data revealed a different developmental order of color term acquisition: *yellow, blue, black, green, white, pink, orange, red, purple, brown* and *gray*. Pitchford and Mullen thus consider color terms to be acquired in two developmental stages. In the first stage children acquire terms for yellow, blue, black, green, white, pink, orange, red and purple and only after substantial delay (6 to 9 months) do they learn to use terms brown and gray. Different outcomes of these two experiments (Johnson, 1977; Pitchford & Mullen, 2006) are probably due to differences in used methodology. In this study I would like to examine whether my results uncover answers similar to those of Johnson (1977) and Pitchford & Mullen (2006) or if they offer findings of a different kind.

Two tests were designated in order to examine these hypotheses and research question. First, categorical perception was tested on children in the age range of 12 to 30 months. *Perceptual category can be considered successfully established when a child is able to demonstrate the understanding of within category similarity and between category dissimilarity.* To indicate a successfully acquired perceptual color category, we use the ability to match two stimuli of a tested color while distinguishing them from two distractive colors.

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[9] Johnson (1977) did not test participants for the knowledge of gray.

The second group of children aged from 31 to 49 months was tested on acquisition of color terms. *Color term is considered to be successfully acquired when a child is able to both comprehend and produce it*. To comprehend a color term means to understand the connection between the perceptual color category and its linguistic equivalent. As an indicator of comprehension we use the ability to match a spoken color term to its visual representation. The production of a color term is the ability to code perceptual category into a grammatically and phonetically correct word. The ability to provide a matching color word when exposed to the sensation of color is taken as an indication of correct production.

Part of the capability to produce color terms should be the ability to comprehend the connection between the perceptual color category and its linguistic equivalent. However, children may produce a matching color term without actually understanding this connection. To avoid such coincidental responses which could cause data distortion, it is necessary to test color term acquisition in two separate tasks.

5.2 FIELD DESCRIPTION

All tested children attended day care centers in the city of Nitra in western Slovakia. Nitra is the fourth largest city in Slovakia with the population of approximately 84 000. In Slovakia there are two types of day care centers for preschool children. The type called *'jasle'* (English equivalent for nursery school) admits children from 1 to 3 years of age. When children cross the age limit of three years they go to *kindergarten* where they stay until they are ready to attend elementary school, which is usually around the age of 6. Children participating in this study attended three different day care centers, of which two were '*jasle*' type and one was a *kindergarten*. Out of these three day care centers two are governed by the city and one is in private ownership.

Table 1: Age distribution of participants for each day care center

Day care center	Number of tested children	Mean age in months	Test
Beethovenova	21	44	Color terms
Bazovského	21	26	Color terms+ Categorical perception
Slniečko	16	25	Categorical perception

5.3 PARTICIPANTS

Testing was performed on 58 preschool children ranging in age from 12 to 49 months (1- 4 years) with the mean of 31, 7 months. Children were divided into two groups according to their age. Group of children aged from 12 to 30 months (Group 1) underwent the categorical perception task and children from 31 to 49 months (Group 2) were tested on color naming. Dates of births of all children were obtained from the headmistresses of day care centers before the onset of testing. The age of the children was counted as number of months lived, where a month was considered a mean of 30 days.

Categorical Perception (Group 1)

The age of children participating in the categorical perception task was purposely chosen low, so that categorical perception would be the only factor influencing the results, as most children aged between 12 and 30 months have not yet acquired color names or cannot yet use them appropriately. The mean age of children who underwent the categorical perception task was 23 months. Group 1 consisted of 28 children attending two day care centers. Of these children, 16 children were from the day care center Slniečko and the remaining 12 children from the day care center Bazovského.

Color terms (Group 2)

The age range of children tested in the color term tasks was 31 to 49 months with the mean age of 40 months. The age range of Group 2 was established so that it included both stages of basic color term acquisition as defined by Pitchford and Mullen (2006)[10]. There were 30 children tested in this group, 21 of which were from the day care center Beethovenova, and the remaining 9 from Bazovského.

Both genders had to be equally represented in both studied groups as girls seem to display more sensitivity to color than boys (Johnson, 1977). The categorical perception group included 16 boys and 12 girls; color term tasks were tested on 14 boys and 16 girls.

Table 2: Age and sex distribution of the participants

	Mean age in months	**Boys**	**Girls**	**Group in total**
Group 1	23	16	12	28
Group 2	40	14	16	30

Distribution of sex and age in both studied groups is shown in Table 2; these numbers only include children whose responses were used in data processing and do not include those who were later dismissed from the study.

5.4 ETHICAL CONSIDERATIONS

In order for a child to participate in the research, an informed consent had to be signed by a parent or legal guardian of the child. Two city owned daycare centers had a general informed consent signed by all the parents for all activities approved by the headmistress. In this case, only a permit from the headmistress of the day care center was needed. Research also had to be granted by the headmistress of the Kindergarten

[10] For more details see section on Color terms in child language

Administration Office in Nitra. This grant was issued for both Bazovskeho and Beethovenova daycare centers together; see its copy in the Appendices.

In the private daycare center Slniečko, informed consent had to be signed by all parents or legal guardians individually. Each parent obtained an information sheet about the research with a detailed description of the methodology and stimuli used. Parents also received an informed consent in two copies, of which both had to be filled in and signed by the parent; one was returned to the researcher and one was kept by the parent. See a sample of the informed consent page in the Appendices. Parents were also informed that all data would be processed in anonymity. To ensure this, right after all data were gathered children's names were deleted and replaced by codes. The code consisted of the first three letters from the child's name and the first three letters from the surname.

5.5 LANGUAGE OF INSTRUCTION

All assignments were performed in the Slovak language. Valuable insight on Slovak color terminology was offered in dissertation thesis of Kristina Rebrová (2008) who used methods and stimuli similar to those in World Color Survey to examine Slovak color terms. Her results confirmed that Slovak language possesses terms for all eleven basic colors as identified by Berlin and Kay (1969). In Slovak color terminology each of these eleven basic color categories has exactly one label except for gray which has two. Both terms 'šedá' and 'sivá' are used to label the same achromatic sensation. Term 'šedá' is much more common in Slovak language what is confirmed by data gathered from the group of adults in apparatus pre-test. In this group, only one participant named gray stimuli as 'sivá' and one adult used both terms 'šedá' and 'sivá' , all remaining adult participants labeled this color by the same term 'šedá'. As for children participating in the production task, those who labeled gray stimuli correctly used only term 'šedá'.

English color names with their translation to Slovak can be seen in Table 3. These terms were used in all three tasks.

Table 3: Slovak color terminology

Color	English	Slovak	Pronunciation
	white	biela	[biela]
	black	čierna	[tʃierna]
	red	červená	[tʃervena:]
	yellow	žltá	[ʒlta:]
	green	zelená	[zelena:]
	blue	modrá	[modra:]
	brown	hnedá	[hɲeda:]
	pink	ružová	[ruʒova:]
	purple	fialová	[fialova:]
	orange	oranžová	[oranʒova:]
	gray	šedá/sivá	[ʃeda:][siva:]

In the color term production task, children had a tendency to invent color names derived from objects that are typical for a given color. For example, they would call yellow- "sunny" (*slniečková*), green – "grassy" (*trávičková*) or just compare the color to something it reminds them of, for example white – "like snow" or blue- "like clouds". Such answers were not considered correct as they display unfinished process of conceptualization. Only the above mentioned terminology was taken into account.

5.6 APPARATUS

Stimuli in both tests were colored wooden cubes the size of 3,8 cubic centimeters each. Cubes were chosen over simple paper squares to evoke a playful mood in children. There were four cubes made in each of the 11 basic colors so the complete testing set consisted of 44 cubes. Cubes were originally regular playing cubes for children with pictures. These pictures were covered by color paper made for the purpose. In the case of white and yellow, two layers of color paper were glued on top of the picture to cover it properly.

Color papers were custom-made especially for this research and their samples are attached in the Appendices. Color parameters were set to create clear examples of 11 basic colors, partially taken from previous research done by Pitchford & Mullen

(2005) and adjusted for printing. Parameters in work of Pitchford & Mullen (2005) were given in coordinates of the Munsell color system, which is too wide to be comprehended by a regular printer. Therefore new parameters were created in the CMYK color model (which is used by most print houses) to match the Munsell coordinates given by Pitchford & Mullen (2005) as closely as possible and to display the most focal of each of the 11 basic color categories. Coordinates used in the research are given in Table 4 in three color models RGB (Red, Green, Blue), CMYK (Cyan, Magenta, Yellow, Key-black) and Munsell.

Table 4: Stimuli parameters in RGB, CMYK and Munsell color systems

		RGB			CMYK				Munsell
	White	255	255	255	0.000	0.000	0.000	0.000	N 10.0/0.0
	Black	0	0	0	0.000	0.000	0.000	1.000	N 0.0/0.0
	Red	240	0	0	0.000	1.000	1.000	0.059	8.0R 4.9/19.8
	Green	0	120	0	1.000	0.000	1.000	0.529	9.1GY 4.2/10.6
	Yellow	240	240	0	0.000	0.000	1.000	0.059	0.7GY 9.1/12.3
	Blue	0	0	240	1.000	0.000	1.000	0.059	6.8PB 3.0/28.1
	Brown	120	60	0	0.000	0.500	1.000	0.529	5.4YR 3.2/8.0
	Purple	120	0	240	0.500	1.000	0.000	0.059	0.2P 3.8/26.6
	Pink	240	0	240	0.000	1.000	0.000	0.059	8.0P 2.6/24.5
	Orange	240	120	0	0.000	0.500	1.000	0.059	3.3YR 6.2/14.3
	Gray	140	140	140	0.000	0.000	0.000	0.529	N 5.7/0.0
	Background	200	200	200	0.000	0.000	0.000	0.216	N 8.0/0.0

Color cubes were placed on a neutral gray background during all tasks to ensure correct perception of colors on the cubes, as different background colors may have a distractive effect. Parameters for the gray background are to be seen in Table 4. The size of the neutral gray paper differed among tasks. Tests of perception only required background the size of 210*297 millimeters (A4) as there were only four cubes placed on it at the same time. Both language tasks were presented on gray paper that measured 210*594 millimeters (two A4's connected by the smaller side) as it had to be long enough to accommodate 11 cubes lined up next to each other.

5.6.1 Apparatus pre-test

Before the onset of experiments with children, stimuli were tested on group of adults to ensure that they display clear examples of the 11 basic colors. Pre-testing took place in a lobby of a bank, one of the branches of ČSOB, again in the city of Nitra in Slovakia. Testing was orally permitted by the director of the branch and each participant was informed about the purpose of research and agreed to partake. Twenty subjects were randomly chosen to represent the adult population. The sample consisted of 10 male and 10 female participants. The mean age of participants was 39,8 years, the youngest of them was 23,6 and the oldest 66,7 years old.

Table 5: Age and sex distribution in stimuli pre-test group

	Male	**Female**	**Group in total**
Participants	10	10	20
Mean age	40,1	39,5	39,8

Each adult was tested individually behind a partition that separated the research environment from the rest of the lobby. The setting was illuminated by daylight with no direct sunlight or excessive shade.

The task for the adult sample group was identical to language production task that was later presented to children from Group 2. Eleven color cubes were lined up next to each other on a neutral grey background. The order of colors in the line was random and different with every tested subject. The instructor pointed to one of the color cubes and asked: "What color is this?" The same procedure was repeated with each of the 11 basic colors. All responses were recorded into prearranged answer sheets together with the participant's full name, sex and date of birth.

Testing was done in the Slovak language where there is one correct answer for each of the 11 presented colors, except for gray, which can be called both *sivá* or *šedá*.

Results of the apparatus pre-test show that correct answers were given by 99,5% of the adult sample group. All participants named 11 basic colors correctly except one male subject who labeled both pink and purple cubes by the same word “ružová,” which is the Slovak equivalent for pink. This can be ascribed to a weaker sensitivity to color sensation displayed in men (Johnson, 1977) or a simple misjudgment. Tested stimuli can therefore be considered as appropriate material to be used in further examination.

5.7 ENVIRONMENT

In the day care centers Bazovského and Beethovenova, experiments took place in children’s classrooms. Classrooms in both centers consisted of three or four rooms: a playing room, sleeping room, cleaning room and changing room (in some cases the changing room was separated from the classroom and shared with other children).

In three cases the testing area was situated in the children’s sleeping room, and in two cases in their changing room to ensure separation from the rest of the classroom and thus eliminate visual or vocal disturbance. In the day care center Slniečko which is situated in a family house, tests took place in a dining room which was separated from the rest of the house by a wall.

One teacher was always present at the examination to help the child feel safe in the presence of a strange person (instructor). The teacher was not allowed to help the children with the tasks in any way; if a child was not responding the teacher repeated the question after the instructor, which turned out to be very helpful.

In all three tasks stimuli were placed on a miniature table at a distance that allowed the child to touch them whilst sitting on a small chair.

The testing area was in all cases situated so that it ensured sufficiency of daylight but avoided direct sun rays or immoderate shade.

Every child received a lollypop as a reward for participation.

5.8 PROCEDURE

CATEGORICAL PERCEPTION (Group 1) - Control task

Before the categorical perception task was administered, all children from Group 1 were given a control task to see if they are capable of judging objects by perceived similarity and also to become acquainted with the principle of the following task. The subject was shown a picture of a frog. He was told what kind of animal it was, advised to hold it in his hands and observe properly. While still holding the picture of a frog, the child was presented a triad of animals: a bunny, cow and a frog (the exact same frog as in the first picture). At this point, the child was asked to look at the triad of animals and point out the same frog as he was holding in his hands. The same procedure was repeated with a bear, duck and a pig. If a child managed to point at the correct picture in both tasks, he proceeded to the color perception task. Out of all tested children only two did not pass the control task and had to be dismissed from the study group, as they were not yet capable of understanding the principle of similarity or could not exhibit it. Testing sets for the control task can be seen in Figures 5 and 6.

Figure 5: Control task stimuli 1.

Figure 6: Control task stimuli 2.

CATEGORICAL PERCEPTION (Group 1) –Categorical perception task

The perception task was based on the principle of perceptual similarity judgment. The child was presented with four color cubes and asked to tell the tested color hue apart from two distractive hues. The tested color was represented by two identical color cubes, and two distractive colors were displayed on one cube each. Distractive colors came from both adjacent and distant perceptual color categories to the tested hue. For example, if a child was being examined for categorical perception of yellow (tested hue), two distracter colors could be orange (adjacent) and blue (distant). Combinations of such color triads were chosen so that they would not duplicate (see Table 6).

At first one of the cubes representing the tested color was placed on a gray background paper in front of the child. After the child had observed it for a moment, the instructor put a triad of color cubes in a line behind the first cube. The triad consisted of one cube in the tested color, one in a distant and one in an adjacent hue to the tested color. The instructor pointed at the first cube and asked the child: “Can you show me another one like this?” The child’s response was recorded in a prearranged answer sheet. This procedure was repeated with all 11 basic colors. All children were able to keep their attention on colors during the whole task.

Table 6: Color combinations used in the categorical perception task

Distractive adjacent	Tested color	Distractive distant
yellow	white	black
brown	black	orange
pink	red	green
orange	yellow	blue
blue	green	pink
purple	blue	red
gray	brown	white
purple	pink	yellow
gray	purple	green
brown	orange	black
white	gray	red

The placement of the tested color in the triad was different with every trial as some children showed a tendency to point to the same place in the line more times in a row. If such behavior persisted in more than three trials, the child was dismissed from the study as his results would not correspond with his true ability to perceive colors. This happened only in one case out of all tested children from Group 1.

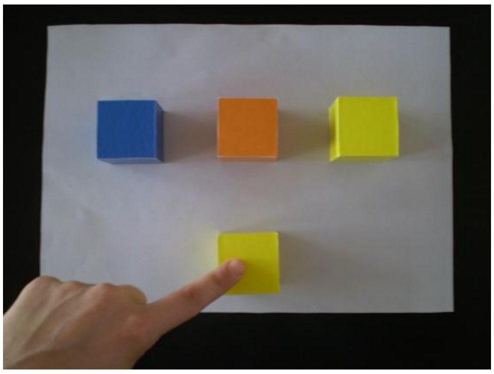

Figure 7: Categorical perception task: "Can you show me another one like this?"

COLOR TERMS (Group 2) - Comprehension task

The comprehension of color terms was tested by the ability of children to match a spoken color term to its visual representation. Eleven color cubes each representing one of the 11 basic colors were lined up next to each other on a gray background paper. The child's task was to point to the color whose name was pronounced by the instructor, for example: "Which cube is blue?" This procedure was repeated with all 11 colors. The placement of colors in the line was changed after every trial for the same reason as in the previous task. No children from Group 2 were dismissed from the study.

COLOR TERMS (Group 2) - Production task

This test measured children's ability to orally produce a matching color name when exposed to the sensation of color. Eleven color cubes were lined up in front of the child like in the previous task. The instructor pointed to one of the cubes and asked: "What color is this cube?" This procedure was repeated with all 11 colors. Presentation of colors was random, different with every participant and trial.

The children were given a time distance of one day between comprehension and production tasks to avoid possible distortion of data. The distortion could have occurred because the concept of color was activated during the comprehension task and would likely have influenced children's responses in the production task if no interference was present. Also the attention of participants would likely have dropped down after the first set of tests.

6 RESULTS

Before we proceed to results evaluation, a couple of remarks on methodology of data processing are needed. Pitchford and Mullen (2006) criticize methodology used in many previous studies concerned with development of color knowledge for they use mean number or percentage of correct answers as the dependent variable and basis for establishing developmental order of color acquisition. Such interpretation of the results can be misleading as it relates the number of children with correct answers to the total number of tested children but doesn't consider the age of children who answered correctly. To avoid such misunderstanding, developmental sequences in this study are compiled of the mean age of children who answered correctly.

Categorical Perception

The number of children who correctly matched two color cubes of a tested hue in the categorical perception task is shown in Figure 8, expressed as a percentage of the sample size. These values express the percentage of correct answers to each of the 11 basic colors in children aged from 12 to 30 months. They were not used to compile the developmental sequence of categorical perception as they do not relate the correct answers to children's age.

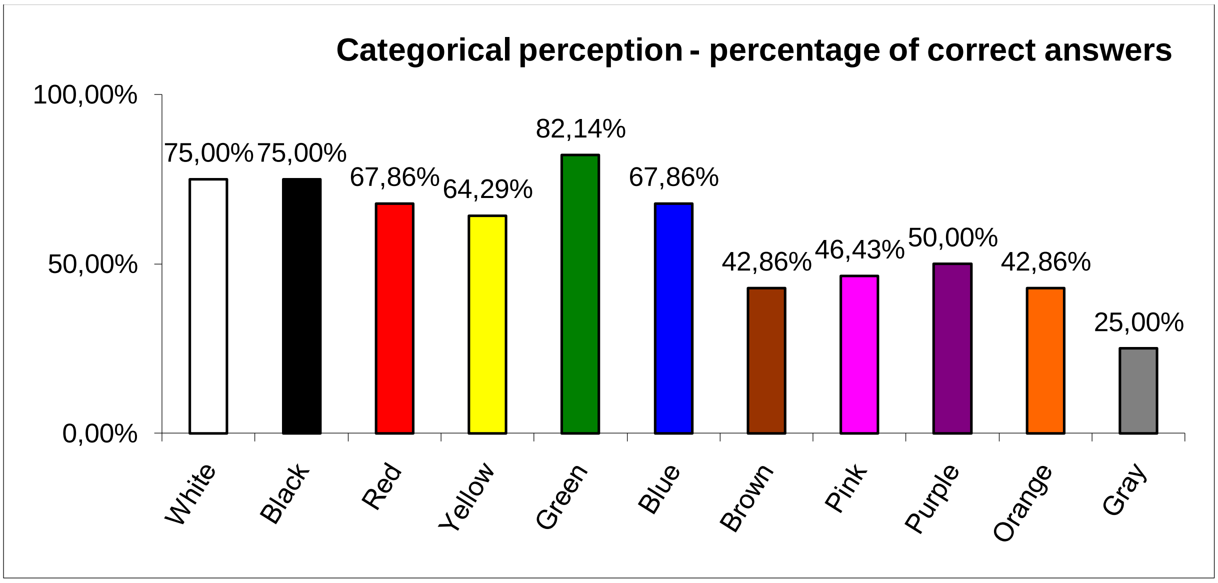

Figure 8: Percentage of correct responses in the categorical perception task

The highest percentage of correct answers was detected in the color green- 82,14 %. This is understandable as green belongs to one of the pure hues, and in color vision physiology is present in both trichromacy and opponency process. The next colors to appear on the percentage scale were white and black equally represented by 75% of correct answers. *Green (82,14%), white (75%)* and *black (75%)* are followed by *blue (67,86%), red (67,86), yellow (64,29%), purple (50%), pink (46,43%), brown (42,86%), orange (42,86%)* and *gray (25%)*. Such would be the developmental sequence if we used the percentage of correct answers as the dependent variable.

Instead, the hierarchy is assessed as a succession of the mean ages of children who answered correctly to each of the 11 basic colors as shown in Figure 9. The mean age of children is presented in days, for if it was shown in months, the differences would not be noticeable. The results of the categorical perception task show that the developmental sequence of perceptual category acquisition in Slovak preschool children is as follows: *green, red, blue, white, yellow, black, brown, gray, purple, pink* and *orange*. These data demonstrate that there is a probability that children categorize certain colors earlier than others. Such order clearly indicates the advantage of primary over secondary colors what can be considered a proof for perceptual categories to arise from the neurophysiology of the human visual system.

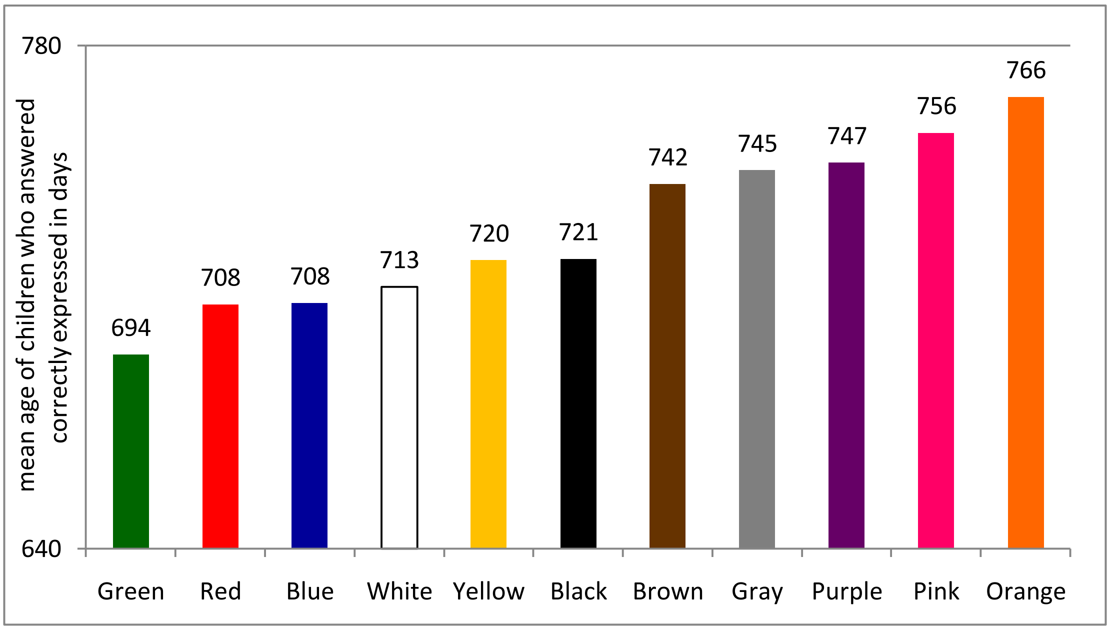

Figure 9: Developmental order of categorical perception

Color terms

Color term acquisition was tested in two separate tasks - comprehension and production. In the production task children had to match a spoken color term to its visual representation. The percentage of correct answers in the comprehension task is shown in Figure 10.

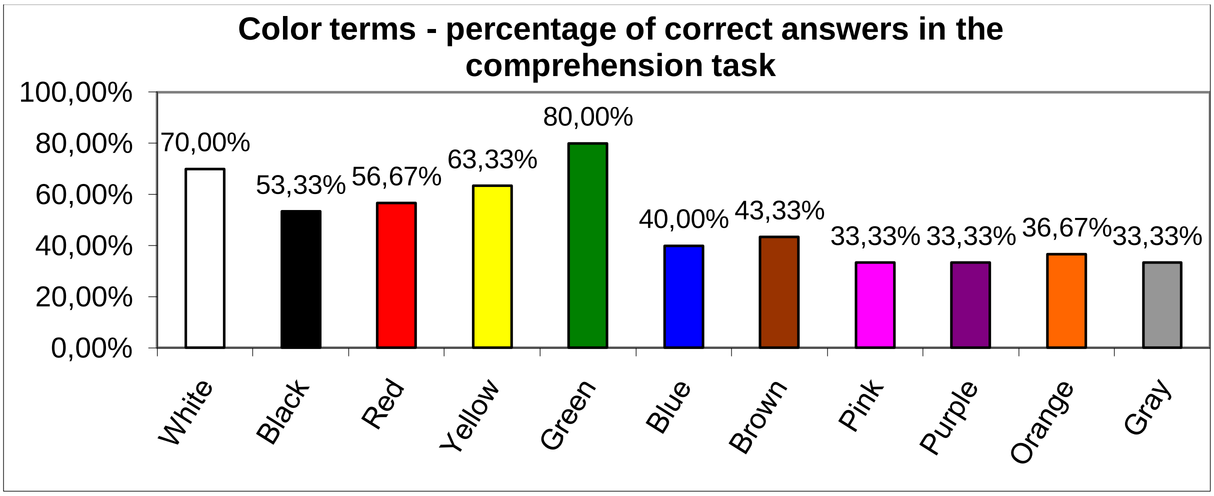

Figure 10: Percentage of correct responses in the comprehension task

The highest number of correct responses 80% was again achieved with the color green. *Green (80%)* is followed by *white (70%), yellow (63,33%), red (56,67%), black (53,33%), brown (43,33), blue (40%), orange (36,67%),* and *pink (33,33%), purple (33,33%),* and *gray (33,33%),* all show the same percentage of correctly answered trials.

The production task results do not necessarily have to correlate with data gathered from the comprehension task. A child may understand the connection between visual and lexical representation of color but may not yet posses the ability to utter the particular color word. The percentage of correctly named colors is shown in Figure 11.

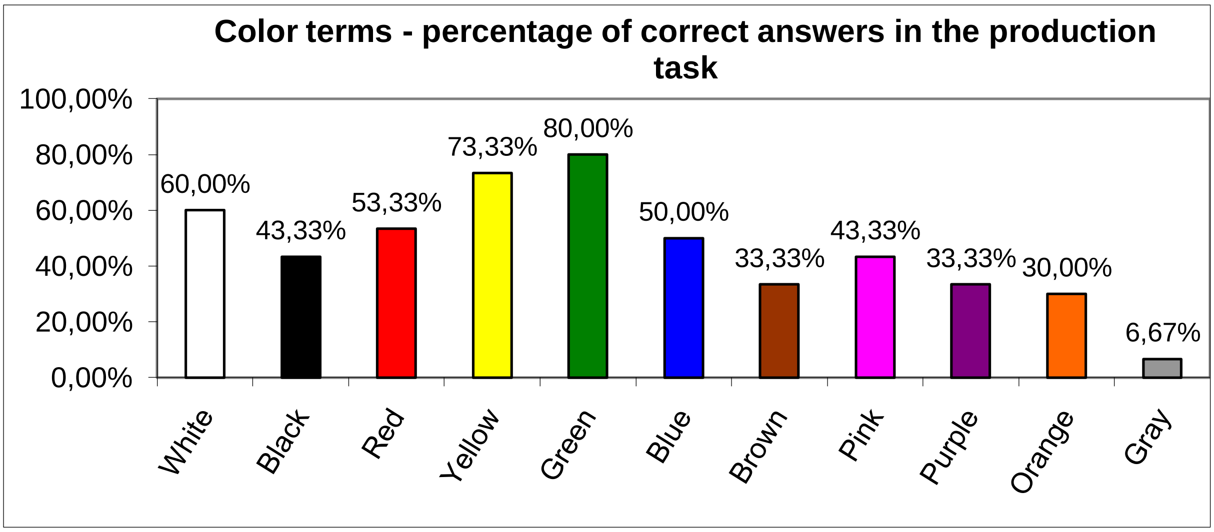

Figure 11: Percentage of correct responses in the production task

Once again, *green (80%)* is the color with highest percentage of correct answers. Other colors follow: *yellow (73,33%), white (60%), red (53,33%), blue(50%), black (43,33%), pink (43,33%), purple (33,33%), brown (33,33%), orange (30%)* and *gray (6,67%).*

To asses the development of color term knowledge we only used mean ages of children who responded correctly in comprehension and production tasks conjointly because even if color term production presumes the ability to comprehend the connection between perceptual color category and its linguistic representation, children may learn to produce color terms without understanding their referential application onto color sensations. Joining the results from both tasks was a way to insure that only children with accurate color term knowledge contribute to the results of color term acquisition. Therefore the number of children with accurate color term knowledge may differ greatly from the amount of children who succeeded in comprehension and production tasks separately.

The developmental hierarchy of color term knowledge is shown in Figure 12. The data gathered in this study demonstrate that the acquisition of color terms in Slovak preschool children develops in this order: *yellow, green, blue, red, pink, black, white, purple, brown, gray* and *orange.*

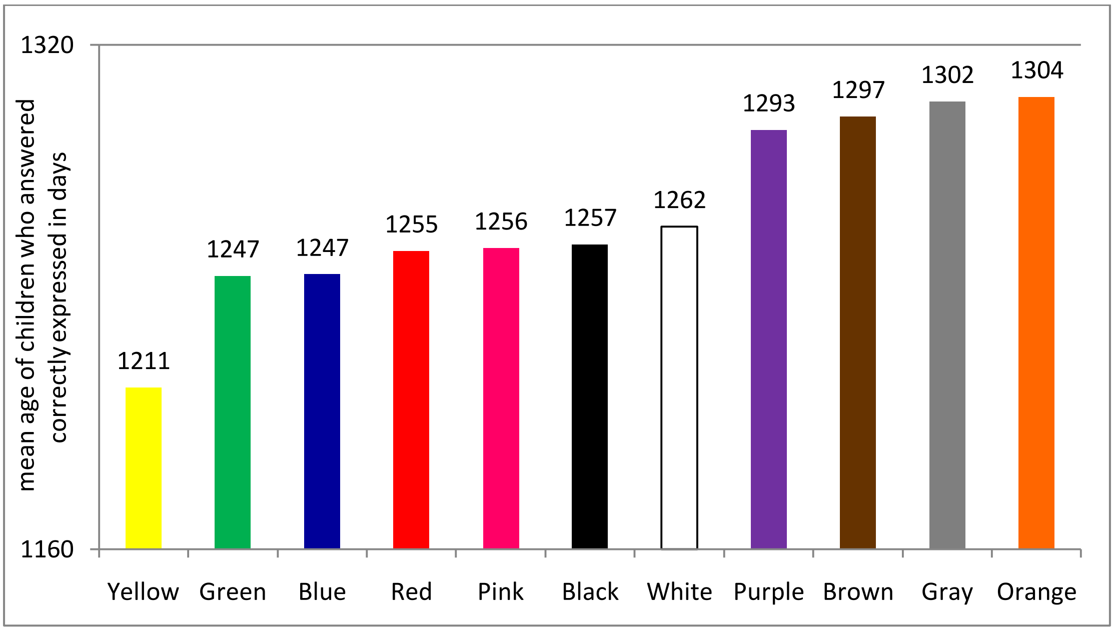

Figure 12: Developmental order of color term acquisition

Although the first four color terms of the hierarchy correspond with the idea of early acquisition of primary color terms, early emergence of pink disturbs the advantage of primary colors over secondary.

To establish the similarity of developmental sequences of categorical perception and color term acquisition I used Kendall rank correlation coefficient, commonly referred to as Kendall's tau (τ) coefficient. It is a measure of rank correlation: that is, the similarity of the orderings of the data when ranked by quantities (Kendall tau rank correlation coefficient, 2006). Very simply put, to calculate Kendall's tau coefficient we pair all colors (for each hierarchy separately) in order to create all possible color combinations and compare the rank positions of colors in pair simply by using symbols higher (<) or lower (>). Next, we compare the relations (< or >) of pairs from categorical perception hierarchy to the same color pairs from color term hierarchy and establish whether they are concordant of discordant. Finally, we calculate Kendall's tau coefficient as follows where *n* is the total number of colors used (11):

$$\tau = \frac{(\text{number of concordant pairs}) - (\text{number of discordant pairs})}{\frac{1}{2}n(n-1)}.$$

Tau value ranges between -1 to 1, 1 meaning the perfect agreement and -1 a perfect disagreement of two rankings. Our results show that τ equals 0, 53 which means that the two compared hierarchies are more similar than dissimilar.

As with regards to my research question, Kendal's tau coefficient was used to measure the similarity between developmental sequence of color terms obtained from the results of this study and Berlin and Kay's (1969) evolutionary order. The correlation of the orderings of the data equals 0, 46 which means that the similarity of these two hierarchies can be considered statistically significant.

7 DISCUSSION

The results of this study demonstrate two developmental orders of acquisition of color in Slovak preschool children, one for perceptual color categories (*green, red, blue, white, yellow, black, brown, gray, purple, pink* and *orange*) and one for color terminology (*yellow, green, blue, red, pink, black, white, purple, brown, gray* and *orange*).

To address the first hypothesis, primary colors clearly precede secondary colors in perceptual category acquisition. Also, the percentage of correct responses to primary colors in the categorical perception task was considerably higher as compared to secondary colors. Although the terms for primary hues of red, green, yellow and blue were acquired among first, the emergence of pink in early stages of color term acquisition disturbed the advantage of primary colors over secondary.

The surprisingly early appearance of pink could be understood if we focus on the gender of children who responded correctly to the pink stimulus. Out of all the correct answers to the pink cubes in the comprehension task, 80% of them were given by girls, in the production task girls contributed by 76,9% . An accurate knowledge (combination of correct answers from both tasks) of color term 'ružová' (pink) was detected purely in female participants. Such results indicate the role of language input on color term acquisition for I would assume that girls encounter the term for pink much more often than boys. However, it raises the question why also other colors which are considered to be 'feminine' (for instance purple or red) didn't appear at the beginning of the list. To answer this question, further research would be needed.

As with regards to the second hypothesis, although the two developmental sequences are not perfect duplicates, similarity between them is statistically significant. Such results suggest that color term acquisition has roots in the physiology of human visual system.

To assess the research question, the similarity between Berlin and Kay's evolutionary order and developmental sequence of color terms turned out to be statistically significant. Although neither results of this research nor developmental sequences proposed by Johnson (1977) and Pitchford & Mullen (2006) display the exact same orderings of colors as Berlin and Kay's hierarchy (1969). Brown, purple and gray appear among the last four color terms to be acquired in all three developmental sequences – Johnson, Pitchford & Mullen and this research- but on the other hand, black and white do not come first in neither of them as opposed to what Berlin and Kay (1969) predicted. To summarize it, there doesn't seem to be a fixed developmental order in acquisition of color terms, perhaps due to number of factors that influence this process.

Interesting phenomena were observed in the results of this study. Firstly, in all three tasks, the color green was the one with the highest percentage of correct answers. It can be ascribed to the fact that both types of photoreceptors (cone and rod cells) have the peak sensitivity around the green region of color spectrum. This clearly indicates a biological predisposition for color sensitivity.

Secondly, the case of gray should also be noted. Gray achieved 33,33% of correct responses in the comprehension task but only 6,67% in color naming. This could confirm the claim by Pitchford and Mullen (2006) on the relatively late acquisition of the color term for gray as compared to other color terms. Pitchford and Mullen (2006) state that this delay may be caused by color preference of children or poor linguistic stimulation from the environment. Although, such a low number of children who have the knowledge of color term for gray could be ascribed to the fact that in the Slovak language there are two different words 'šedá' and 'sivá' that describe this achromatic sensation. However, it is possible that both the duality of color terms and delay in acquisition of gray equally contributed to such low number of children with the knowledge of term for gray color

To summarize the results of this study, an advantage of primary colors over secondary in the categorical perception and partially in color term acquisition was confirmed, suggesting a strong influence of color vision physiology on color acquisition. This claim was supported by the similarity of both categorical perception and color term developmental sequences and a major advantage of the color green in all three tasks. However, the early appearance of pink and late acquisition of a term for gray suggests the influence of language on color acquisition.

From this we can conclude that color acquisition has its roots in the physiology of human visual system which are visible especially in the early stages of child development. However, in the subsequent stages of color acquisition, language starts playing the role.

8 SUGGESTIONS FOR FURTHER RESEARCH

There is still so much that we do not know about color. Here I would like to suggest several issues which could be investigated in order to help us further understand how children acquire color.

First of all, although this study did not focus much on the language input of color, gender seems to be an important factor influencing it. An empirical investigation on the interdependence between language and gender, and factors underlying it may bring light to the question why girls display more sensitivity to color than boys.

Secondly, the influence of other social factors for example social class may play a significant role in color acquisition. Research could be carried out to compare color knowledge in children from state and private day care centers. I am aware that also results of my study may have been influenced by this social factor as one of the day care centers participating in the research was in private ownership. Some can see private day care centers as less representative of the population as compared to the city or state owned ones as these charge considerably higher tuition, and thus attract parents from a higher social class. This differentiation in educational facilities can give these pupils an advantage over others, a fact that can be reflected in a child's test results. Also the fact that private day care centers have fewer children per teacher, allowing the teacher to dedicate more time to child's education, plays its role.

Finally, a valuable insight may be brought to understanding color by a study focused on color acquisition in bilingual children. As confirmed by this research, there is a significant influence of language in color term acquisition but there is not much known about how children with two mother tongues learn color terms.

APPENDICES

Apendix A. Informed consent in Slovak (A1) and English (A2)

The original consent as it was presented to parents was written in the Slovak language; translation to English was done by the author.

Appendix A1.

Informovaný súhlas rodiča (zákonného zástupcu)

Ja, ... súhlasím s účasťou môjho dieťaťa..., narodeného

dňa .... v štúdii osvojovania farieb u detí predškolského veku.

Bol(a) som zrozumiteľným spôsobom informovaný(á) o dôvodoch, význame a rozsahu tejto štúdie. Prečítal(a) som si a pochopil(a) text „Informácie pre rodiča (zákonného zástupcu) účastníka štúdie“ a informovaného súhlasu. Moje otázky boli zodpovedané zrozumiteľným spôsobom a dostatočne podrobne.

Vyhradzujem si právo kedykoľvek zrušiť svoj súhlas.

Beriem na vedomie, že všetky dáta budú spracované anonymne.

Podpis rodiča: .... dátum: ....

Appendix A2.

Informed consent of parent (legal guardian)

I .... agree with the participation of my child..., born .... in the study of acquisition of colors in preschool children.

I was informed, in an articulate manner, about the purpose, relevance and extension of this study. I have read and understood the text "Information for parent (legal guardian) of the study participant" and the informed consent. My questions were answered in an articulate and detailed manner.

I reserve the right to cancel my consent at any time.

I am aware that all data will be processed anonymously.

Parent's signature:... date: ....

Appendix B. Grant for the research, issued by the headmistress of the Kindergarten Administration Office in Nitra

Správa Materských škôl v Nitre
Na Vŕšku 4, 949 01 Nitra

Katarína Líšková
Beethovenova 2
949 11 Nitra

Vybavuje/linka	*Nitra*
Kolenčíková 037/651 63 03	20.apríla 2010

Vec
Súhlas so vstupom do MŠ

Riaditeľka správy materských škôl – Mgr. Kvetoslava Mikulová týmto
vydáva súhlas
na vstup do MŠ Beethovenova a MDJ Bazovského, Kataríne Líškovej, za účelom vykonania 4-dňového pedagogického pozorovania potrebného k realizácii bakalárskej práci.
Toto povolenie sa vydáva na obdobie od 12.4.2010 do 26.4.2010.
Povolenie na vstup závisí na rozhodnutí a záujme materskej školy.

S pozdravom

SPRÁVA MATERSKÝCH ŠKÔL
NITRA
- 2 -

Mgr. Kvetoslava Mikulová
riaditeľka
Správy materských škôl v Nitre

Telefón	Fax	Dexia Nitra	IČO	E-mail
037/651 63 03 sekretariát 037/655 47 35 pers.a mzd.úsek 037/655 47 36 ekonom. úsek 037/655 47 37 organizač.úsek	037/ 651 63 03	0861945006/5600	37965409	spravams@smsnitra.sk

Appendix C. Color samples used in the research

Can be found under the back cover.

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