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Does Ageing Have an Impact on Color Preferences: A Study of Color Preference Trends in Croatia?

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Abstract: Attracting and retaining the attention of users, or motivating them to use the particular product being the main task of designers in graphic design for all materials, from printed to digital media. It is crucial to select colors that are more appealing to the target audience. The aim of this paper is to explore the differences in color preferences depending on age groups in a nationally representative sample of the Republic of Croatia consisting of 1,000 research participants. For this purpose, a questionnaire was created to collect information on the color preferences of participants, and as a result of this research, it was determined that there are statistically significant differences in the preferences for certain colors depending on the age groups of the participants. It has also been shown that there are both increasing and stable or decreasing trends in color preferences depending on age groups.

Keywords: color; color preference; communication materials; graphic design; visual communication

1 INTRODUCTION

Graphic communication strives to convey specific messages through carefully selected and harmonized visual elements. To successfully communicate ideas and intended messages, graphic designers use carefully chosen visual elements such as line, shape, color, texture, and typography. Among all the visual elements available to graphic designers, color stands out as one of the fundamental communication channels through which humans interact with their environment. Despite this deep-rooted significance of color in human nature, the semantic interpretation of colors is not universal but can vary significantly depending on numerous cultural, social, and individual factors [1, 2]. The experience of colors is one of the key elements that require special attention when creating visual communications that are intuitively understandable, aesthetically pleasing, and functionally aligned with design objectives. Understanding color preferences is extremely important in graphic design, both for conventional graphic and contemporary digital media, as it plays a crucial role in how viewers interpret visual messages. Through this understanding, designers can better communicate, connect with the target audience, and create visually attractive graphic products. On the other hand, the use of certain carefully selected colors is essential for the visual design. In the case of advertising, the goal is to create visually interesting products where the correct use of colors can significantly reduce cognitive load when using the user interface. This approach also facilitates easier learning for new users, often based on the intuitive use of graphical elements, positively affecting the learning path. Given that colors are one of the fundamental communication channels between humans and their natural environment, it is clear that a deeper understanding of colors can contribute to building systems of human communication and interaction with the environment. Therefore, it is evident that thoughtful and conscious use of colors in graphic design is not just advisable but necessary [3-4]. Given this undeniable importance, it is crucial for graphic designers to understand how people perceive colors and to continuously research market preferences and refine their expertise in the color domain to achieve the desired effect in the designs they create [2].

Color preference, as a concept, refers to individual and collective inclinations towards certain colors or color palettes, and understanding these inclinations can lead to the difference between successfully and unsuccessfully designed communication materials [5-6]. By selecting colors according to user preferences, it is possible to increase brand recognition, improve the perception and understanding of information, and stimulate desired reactions from observers, one of the most important being the retention of attention [6-13]. When creating digital content, designers must consider color semantics to meet user needs and improve the user experience [14].

An individual's age has a significant impact on the preference for certain colors, and color preference changes from early childhood to mature age. Numerous studies have shown that as people age, there are changes in color perception, experience, and preferences [15-20]. Some research has concluded that children often show a marked preference for bright and vivid colors, while older individuals tend to prefer subtler, more neutral shades, and darker tones [21-23]. There are general tendencies for people, regardless of age, to prefer cool colors like blue over warm colors like orange and yellow [17, 24-26].

Research on color preferences has typically been conducted in two ways: through color stimulation, where participants are visually shown a color, and through naming colors, where only the name of the color is used without visual stimulation [17]. In this paper, research will be conducted using color stimulation.

2 RESEARCH DESCRIPTION

For the research, a questionnaire was created consisting of basic demographic questions to monitor the completion rate of the research participant sample, as well as questions about color preferences. Eighteen colors were selected for the

examination, which are part of the X-Rite ColorChecker (Fig. 1). These colors were chosen because, in addition to the colors of additive and subtractive synthesis (Red, Green, Blue, Cyan, Magenta, and Yellow), it includes 12 colors that represent the coloring of objects and phenomena in nature, as defined by the description of the tool itself, colors of the most common photographic motifs [27]. Due to the time constraints of the research, it was necessary to rationalize the number of colors on which the research would be conducted, and by the estimation of researchers and authors, this set of colors is useful for understanding color preferences. Also, a peculiarity of this system is that it is used in monitoring color reproduction through digital systems and is adapted for reproduction in the RGB color space.

Figure 1 Display of tested colors with hexadecimal color code

Research participants received the questionnaire via email and completed it on a computer; it was not possible to complete it with phones or tablets. Studies have shown that the results of testing color preferences online, where conditions are not fully controlled (such as screen calibration, lighting, etc.), do not significantly affect the outcomes [24]. Also, the very nature of human-computer interaction, especially in terms of graphical user interfaces, is based on their interaction with personal computers, which significantly contributes to the relevance of the collected data.

The sample of respondents was created in cooperation with Ipsos Croatia, representing a nationally representative sample in the Republic of Croatia, with 1,000 participants carefully distributed by gender, age, and place of residence, to ultimately represent the views on color preferences of the population of the Republic of Croatia. For the purposes of the research, participants aged between 18 and 65 years were selected and divided into three age groups: "younger segment of the population," covering participants aged 18 to 29, "middle segment of the population," covering participants aged 30 to 45, and "older segment of the population," covering participants aged 46 to 65.

After answering the demographic questions, research participants were shown one color on the screen, for which they had to respond how much they liked it among the offered answers "I really like it," "I kind of like it," "I neither like nor dislike it," "I kind of dislike it," and "I really dislike it," as shown in figure 2. After they answered the question, the next color was displayed, and this continued until they had given their response for all 18 tested colors. The colors were presented in a random order, meaning that the sequence of colors shown was different for each research participant, so as not to influence their responses.

Figure 2 Display of color preference question

3 RESULTS ANALYSIS

The study involved 1,000 participants, of which 198 were in the younger segment of the population, 356 in the middle segment, and 446 participants in the older segment, in order to answer the question of whether a person's age affects color preference.

3.1 Statistical Analysis

The data were processed in the JASP 0.18.1.0 statistical analysis software. To check the normality of the data, i.e., whether the data fit or deviate from a normal distribution, it was necessary to conduct the Shapiro-Wilk test, which showed p-values of $< .001$ for all tested data. This value indicates that non-parametric statistical methods are needed for further data analysis. In this case, when comparing more than two groups of independent variables, in this instance, three age groups, the Kruskall Wallis non-parametric test was used. Tab. 1 shows that the Kruskall Wallis test revealed a statistically significant difference between the observed color and age groups for the colors Dark skin ($p < .001$), Light skin ($p < .001$), Foliage ($p = 0.023$), Purplish blue ($p = 0.023$), Moderate red ($p = 0.032$), and Yellow green ($p = 0.022$). For all other observed colors, the test showed that there is no statistically significant difference between the observed colors as the dependent variable and age groups as the independent variable, leading to the conclusion that color acceptance in the Republic of Croatia is consistent across all age groups.

Table 1 Significance of differences in color preferences among age groups where 1 represents the younger segment of the population, 2 - the middle segment of the population, and 3 - the older segment of the population.

Color	Age Group	Mean Rank	Kruskal Wallis	*p*
Dark Skin	1	2.578	15.497	**<.001****
	2	2.525		
	3	2.827		
Light Skin	1	3.434	18.430	**<.001****
	2	3.042		
	3	3.031		
Blue Sky	1	3.495	0.913	0.634
	2	3.556		
	3	3.594		
Foliage	1	3.091	7.545	**0.023***
	2	2.924		
	3	3.17		
Blue Flower	1	3.505	1.018	0.601
	2	3.638		
	3	3.585		
Bluish Green	1	3.712	2.759	0.252
	2	3.801		
	3	3.684		
Orange	1	3.005	4.696	0.096
	2	2.916		
	3	3.078		
Purplish Blue	1	3.662	7.571	**0.023***
	2	3.89		
	3	3.886		
Moderate Red	1	3.702	6.870	**0.032***
	2	3.539		
	3	3.455		
Purple	1	3.419	1.088	0.581
	2	3.565		
	3	3.509		
Yellow Green	1	3.152	7.615	**0.022***
	2	3.413		
	3	3.444		
Orange Yellow	1	3.071	2.373	0.305
	2	2.997		
	3	3.103		
Blue	1	3.783	5.876	0.053
	2	3.994		
	3	3.973		
Green	1	3.596	1.319	0.517
	2	3.671		
	3	3.706		
Red	1	3.793	0.842	0.656
	2	3.775		
	3	3.688		
Yellow	1	3.359	1.607	0.448
	2	3.435		
	3	3.484		
Magenta	1	3.348	4.803	0.091
	2	3.601		
	3	3.512		
Cyan	1	3.934	4.501	0.105
	2	3.994		
	3	3.843		

*$p < 0.05$, **$p < 0.001$

To determine the nature of the differences between specific age groups, for each color where the Kruskall Wallis test showed a statistically significant difference, a Post-hoc Dunn test with Bonferroni correction was conducted, given that it controls the probability level of Type I error in multiple comparisons. The results of these tests are presented in Tab. 2, and a Box plot graph visualizing the statistically significant differences (graph 1) was created.

Table 2 Dunn post-hoc analysis of the significance of differences in color preferences between age groups (where 1 represents the younger segment of the population, 2 the middle segment of the population, and 3 the older segment of the population)

Color	Age Group	z	*p*	p_{bonf}
Dark Skin	1-2	0.363	0.717	1.000
	1-3	-2.683	0.007	**0.022***
	2-3	-3.669	<.001	**<.001****
Light Skin	1-2	3.819	<.001	**<.001****
	1-3	4.009	<.001	**<.001****
	2-3	0.052	0.959	1.000
Foliage	1-2	1.500	0.134	0.267
	1-3	-0.713	0.476	0.476
	2-3	-2.728	0.006	**0.019***
Purplish Blue	1-2	-2.484	0.013	**0.039***
	1-3	-2.539	0.011	**0.033***
	2-3	0.047	0.963	1.000
Moderate Red	1-2	1.570	0.116	0.349
	1-3	2.611	0.009	**0.027***
	2-3	1.179	0.238	0.715
Yellow Green	1-2	-2.293	0.022	0.066
	1-3	-2.674	0.008	**0.023***
	2-3	-0.352	0.725	1.000

*$p < 0.05$, **$p < 0.001$

Based on the results of the Post-hoc analysis shown in Tab. 2 and the visualization of statistically significant differences displayed in Fig. 3, it can be observed that the color Dark Skin is more favored by the older segment of the population compared to the younger and middle segments. For the color Light Skin, it is evident that it is more liked by the younger population compared to the middle and older segments.

For the color Foliage, it can be seen that the older segment of the population prefers this color more compared to the middle segment. The results also suggest that the color Purplish Blue is more favored by the middle-aged and older population compared to the younger segment, while the color Moderate Red is more liked by the younger part of the population in comparison to the older segment. Conversely, the color Yellow Green is more favored by the older segment of the population compared to the younger age group.

A closer examination of the data reveals that three of the previously mentioned colors are preferred more or less by certain segments of the population compared to the other two age groups, specifically Dark Skin, Light Skin, and Purplish Blue. The color Dark Skin is more liked by the older segment of the population compared to the younger and middle segments. The color Light Skin is more favored by the younger segment of the population compared to the middle and older segments, while, conversely, the color Purplish Blue is less liked by the younger segment of the population compared to the rest of the population.

3.2 Trend Analysis

For the purpose of analyzing trends across all 18 tested colors, a graph was created that displays the trends of average ratings for each color across the three age groups (Fig. 4).

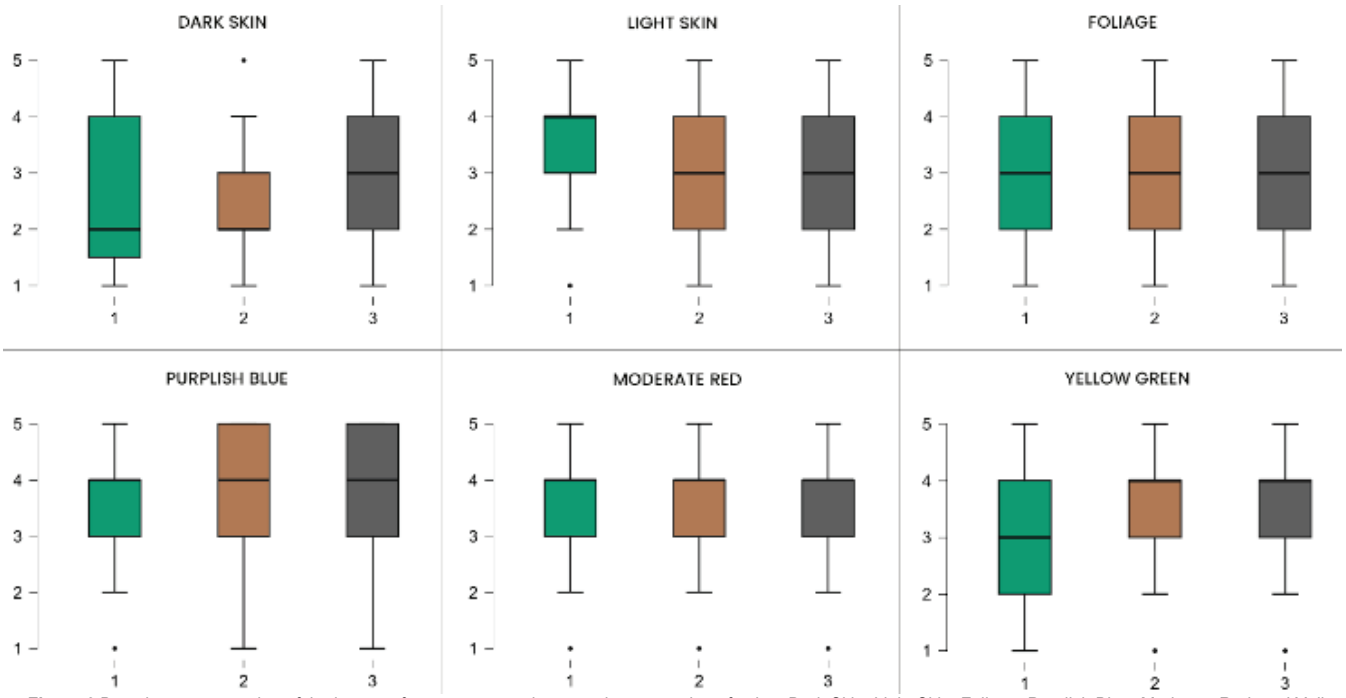

Figure 3 Box plot representation of the impact of age groups on the attractiveness rating of colors Dark Skin, Light Skin, Foliage, Purplish Blue, Moderate Red, and Yellow Green - Visualization of statistically significant differences where the x-axis represents the age groups (1 - younger segment of the population, 2 - middle segment of the population, and 3 - older segment of the population) and the y-axis represents the color preference ratings. **Box plot explanation: Box** represents the interquartile range (IQR) from 25% to 75% of values, **Thicker line** represents median, **Whisker** represents minimum and maksimum value while **Outliers** represents extreme values

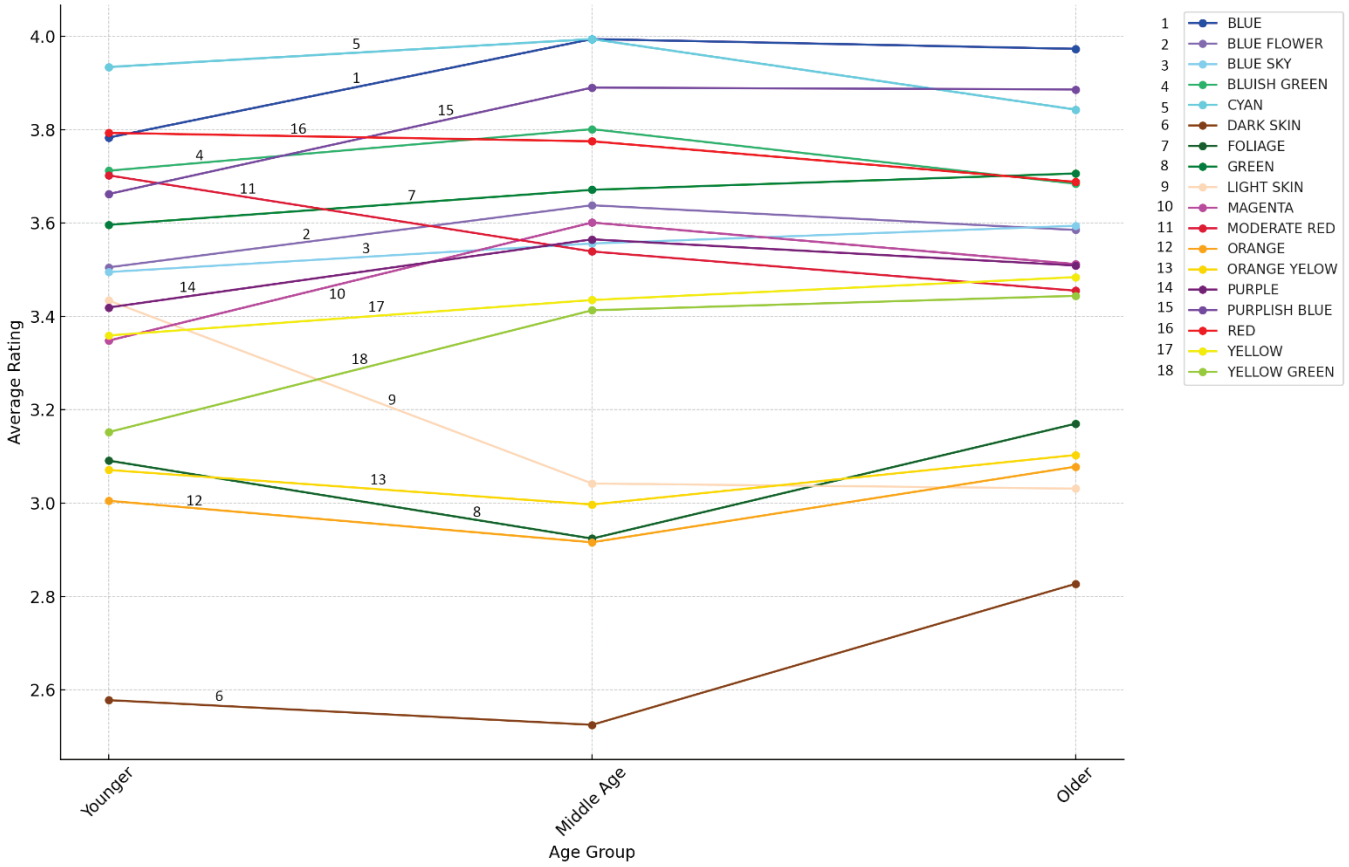

Figure 4 Analysis of color preference trends among age groups

Through the analysis of average color ratings across three age groups (Fig. 4), it can be concluded that general trends in the preference for shades of blue, such as Blue, Blue Sky, Bluish Green, Cyan, and Purplish Blue, indicate they are generally highly rated among age groups with slight variations, suggesting a wide acceptance of blue shades. The colors Blue and Cyan show a specific trend of acceptance and have high average ratings across all age groups, while Blue Flower and Blue Sky show less variation in average ratings among age groups, which may suggest that specific color shades have a more consistent perception across different age groups. Colors containing green shades, such as Green, Yellow Green, and Foliage, have medium to high ratings, reflecting a generally positive perception of the color green. The color Light Skin shows the greatest difference in preference among age groups, with a preference trend significantly declining from the younger to the older part of the population. The results also show that the color Dark Skin is the least accepted of all the colors among all three age groups of research participants.

From the results, it can be inferred that regularities in the data may indicate that there are slight preferential differences among age groups of respondents, but there are also similarities in color perception and acceptance. It can be concluded that preferences for some colors, such as blue and its variants, which typically symbolize peace, trust, stability, and purity [28, 29], show consistency and universality in preferences among all age groups. In contrast, colors containing green shades have medium to high ratings, reflecting a generally positive perception of green color associated with nature, growth, and renewal, while more neutral colors such as Light Skin, Orange, and Orange Yellow show weak preferences within the population. The color Dark Skin, which closely resembles the color Brown, shows general unacceptability across all three age groups of research participants, which is not surprising as studies have shown that people associate it with dirt, mud, decay, etc. [29, 30].

The trend analysis provided several key insights into color preference results relative to the age groups of research participants. Some colors show an increase in popularity with age, while others have more stable ratings or even a decline, indicating that color perception and preference vary with the age group of respondents. Most colors show relatively stable average ratings across age groups, with certain fluctuations suggesting that, although there are personal preferences, there is also a certain consistency in color perception among different age groups in the territory of the Republic of Croatia. Some colors have more pronounced trends, either increasing or decreasing, which may reflect specific cultural, aesthetic, or psychological preferences that change with age.

4 CONCLUSIONS

The aim of the paper was to discover whether differences exist and to analyze trends in color preferences depending on the age of research participants in the Republic of Croatia, and the results showed that there are certain differences in preference influenced by the age of the participants. It was also shown that there are certain increasing and decreasing, as well as stable trends in color preferences depending on the age groups of research participants.

From all the above, certain guidelines can be provided in terms of using specific colors depending on the age groups for whom the designed graphic product is intended. It can be suggested to use shades of blue color, and to a lesser extent shades of green color regardless of age groups, while it is recommended to avoid using colors Light Skin, Orange, and Orange Yellow and similar ones. Colors that show a pronounced declining trend in preference among age groups, such as Moderate Red and Light Skin, could be used when creating content for the younger segment of the population but should be avoided in other age categories. Of course, colors that are not recommended should be used if a graphic solution is being designed for, for example, a product campaign that is precisely such a color, but in that case, it is necessary to choose a combination of colors (e.g., in the background) that will neutralize the negative impact and present the product in a way that it becomes attractive to targeted users.

This research has opened up possibilities for conducting further studies that should include additional social and cultural criteria such as gender, place of residence, place of upbringing, etc., to gain a more detailed and precise insight into color preferences. Additionally, research with color combinations should be conducted to get an insight into to possibly make "unattractive" colors more attractive to targeted users, all in order for designers to gain a better understanding of all aspects of color preferences and their combinations when designing graphics.

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