Available online at www.ijournalse.org

Emerging Science Journal

(ISSN: 2610-9182)

Vol. 6, No. 4, August, 2022

Color Preferences for Morning and Evening Chronotypes

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Abstract

The presented paper deals with the symbolism of colors, i.e., color associations. The aim of the paper is to verify the correlation of colors and their symbolism. The combination of color and its meaning was based on the existence of a physiological variable, namely the psychophysiological state. The diurnal preference of individuals was used for this purpose, which divided the subjects according to the chronotype into morning and evening groups. From this starting point, the color preferences of the examined people were monitored in the final phase by means of a color evaluation test. The theoretical part of the paper provides a theoretical framework and starting points for research. The research part describes in detail the research process, especially the methods used. The research itself was attended by 720 people aged 20–40 years. As research methods were used: the Composite scale of morningness, Bourdon's performance test, the Subjective scale of activation, and the Color evaluation test. The respondents had the task of associating colors with their current psychophysiological state. The established hypotheses were mostly confirmed. From a broader point of view, we have come to the conclusion that people attribute certain properties to individual colors, so there is psychic content belonging to individual colors. The colors expressing activity included yellow, orange, and red, and respondents from the group of evening chronotypes also included blue. Calm colors include blue, green, and gray. The most indifferent color was purple. The obtained results were statistically significant. There were also relatively strong correlations in the evaluation of colors due to the psychological focus of the research. Other stimuli for research were also found in the research.

Keywords:

Color Psychology;
Color Associations;
Symbolism of Colors;
Chronopsychology;
Diurnal Preferences;
Chronotype.

Article History:

Received:	10	January	2022
Revised:	04	May	2022
Accepted:	21	May	2022
Available online:	29	May	2022

1- Introduction

The world we live in is colorful. We buy colorful clothes, we paint our homes with different colors, and we complement our lives with objects of different colors. Everything we perceive with our eyes has a color. Color is defined by Anton [1] as a perception that is mediated by the human eye. From a physical point of view, it is the decomposition of light into individual color components, so the color really exists on a subjective level. It is a visual perception caused by the wavelength of light. The composition of the light spectrum evokes objective irritation of the retina, and a color perception is created in the brain. Plháková [2] adds that human eyes are able to convert light waves into nerve impulses, which the human brain and the mind interpret as a color. We perceive different colors around us due to the fact that light rays have different wavelengths after passing through matter or reflection.

Even as a child, we learn to name colors before we can count or write. It is appropriate to ask why this is so. Are colors so important to us? Yes. They are. We perceive the world with the help of colors, and most of us cannot even imagine it without them. When we perceive an image and it is not as we would expect, we feel impoverished. Let's remember the constant hunt for color TVs or color displays on mobile phones. Colors are all around us, and they also affect us in some way. In addition, we use colors as symbols and we have a certain relationship with them.

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DOI: http://dx.doi.org/10.28991/ESJ-2022-06-04-010

Many research and studies, e.g. Jeon et al. [3], and Palmer & Schloss [4], have been conducted in the field of psychological or physiological effects of colors on humans and color associations, but the conclusions drawn and other diagnostic methods are still met with distrust by proponents of methodologically accurate theories. Color research is often accompanied by criticism of the diversity of studies, validity and generalization of results [5] or of symbolic interpretation of results, and insufficient explanation of parametres relationships [6]. The aim of the presented paper is to verify the correlation of colors and their symbolism. We based the combination of color and its meaning on the existence of a physiological variable, namely the psychophysiological state. The diurnal preference of the individuals was used for this purpose, which divided them according to the chronotype into morning and evening groups. From this point of view, the color preferences of the subjects were examined in the final phase using a color test.

The outputs of presented research are currently essentially unique, because in the conditions of the Czech and Slovak Republics a similar research was last carried out by Veverková in 2002 [7] and by Skočovský in 2004 [8]. Within last 5 years, there are available only the outputs of researches carried out in the context of bachelor's and master's theses processing often only to examine color preferences in different ethnicities or of children, or in the context of experience. The closest to our research is the work by Hrstková (2005) [9], which examined color preferences depending on the degree of extroversion. The aim of this research was to confirm the hypothesis that there is no relationship between the preference of warm colors and extroversion among university students, and this hypothesis was refuted. Relevant research, for example Fárková et al. [10], and Jiang et al. [11], has been available in recent years to examine chronotypes, but it is not about examining the relationship between chonochronotypes and color preferences. This situation of the relevant research outputs and results is also copied by the situation outside the geographical borders of the Czech and Slovak Republics. Most researches focused on the study of color preferences focuses on the choice of colors when creating interiors, such as Baniani & Yamamoto [12], and Torres et al. [13] or in the context of shopping behaviour [14], researches focused on the study of chronotypes aim at sleep research today mostly with emphasis on the impact of pandemic disease COVID-19, such as Staller & Randler [15] and Genta et al. [16].

Therefore, there are currently no research available that brings relevant results in the context of the issues we address, which we would supplement with our research for the conditions of the Czech or Slovak Republics, so we dare to say that both our research and its outputs are unique to the Czech and Slovak Republics conditions.

2- Literature Review

2-1- Research on Color Preferences and Symbolism

J. W. Goethe is considered to be the founder of the study of color from a psychological point of view. At a time when the science of color has been reduced to physical and physiological ways of thinking, Goethe highlights and describes an important psychological aspect of the experience of color, namely sensory action. His research is based on ancient Greek ideas about colors. Among other things, Goethe divides colors according to the effect of positive and negative colors, sets the rules of color harmony and, overall, he contributes greatly to the spread of knowledge about the psychological and physical effects of color, although many of his theories are now obsolete [7]. Goethe claimed that all colors arise from light and darkness. Darkening of white light produces a yellow color, darkening of black produces a blue color. These are two of the basic colors that Goethe placed in the corners of the colored triangle. In the third corner stood red, which is said to be created by the "escalation" of yellow and again drops through purple to blue [17].

Fechner [18] tried to lay the foundations for the aesthetic effect of colors and to shed light on the preference for certain colors in different historical periods. Cohn's study [19] is considered a pioneering work in the field of color psychology, which found out how the individual components of the color stimulus condition the preference of individual colors in terms of pleasantness and inconvenience. The degree of preference for a particular color stimulus has come to be referred to as the affective value of a color. Cohn concludes that there is a general preference for maximally saturated colors. However, she also found that certain people prefer low-saturated colors. Research has thus supported the idea of Veverková [7] that there are individual differences in color preferences. . This conclusion is also confirmed by the Luckiesh´s study [20]. In the 1987, Grossberg [21] confirms and complements Cohn's research [19]. More popular are light and more saturated colors.

Based on his research of 13,625 people, Eysenck [22] claims that there is a specific general universal order of colors - blue, red, green, magenta, orange, yellow. His findings, like Grossberg´s research [21], were challenged in the 1990s. Bažány [23] argues, based on his research from 1961 that the affective value of colors depends on certain biological and physiological factors rather than on cultural influences. Sevinc focused on examining the experiential quality of colors [24]. In this research, researchers combined colors with adjectives, thus proving a certain connection between certain colors and certain feelings. The Lawlers [25] conducted research on children in kindergarten, resulting in a yellow color signifying a hilarious story and a brown a sad story. Birren's [26] claim that introverts prefer cold colors and extraverts warm colors refuted [27]. Kaya & Epps [28] analyzed color-emotional associations in college students. He concluded that light colors usually evoke positive emotional associations, with women reacting more negatively to dark colors. Norris et al. [29] based their research on mental fatigue as an unpleasant experience from which respondents assessed the pleasantness of the colors presented.

Schaie (1961) assumed that more than one color could be assigned to a certain feeling. In his research based on associations and mood, he found that the most exciting and stimulating respondents identified yellow, orange and red [30]. However, blue has also been associated with arousal and stimulation. Respondents had no strong association with green. The other colors in this association were blue, green, purple, white, black, gray, and finally brown. Blue, white, gray, purple, brown, black, green, yellow, red, orange, were marked as calm, peaceful, and quiet. Palmer et al. [31] focused their research on color associations on music. Based on several musical examples, the respondents were associated with six different colors. Lee et al. [32] examined color and temperature associations in six, twelve, and eighteen-year-olds. Only in eighteen-year-olds the general association of the warmest red, warm yellow, cool green and the coldest blue was confirmed, twelve-year-olds also confirmed red as the warmest color.

Hall [33] conducted on 5,375 students of philosophical faculties, design and architecture. The research covered 20 countries, such as Japan, China, Korea, India, Taiwan, etc. 47 different colors in different shades were used for this research. The results of the research pointed out local differences in colors associated with some meanings, for example war associated with red was replaced with black among Japanese students, peace was associated with white, light yellow, and light blue. Another study of the importance of colors and their marketing preferences was conducted in ten countries in Europe, Asia and America on 253 respondents by Madden et al. [27]. Red was cited as the most active and exciting in the research. Then the order was as follows - in the same positions gold, orange and yellow, a degree less purple, brown and black and on the other hand blue, green and white were marked as passive, soothing and cold colors.

A 2001 survey by Moore et al. [34] on color symbolism, conducted on more than 1,000 respondents, primarily from the United States, cites red as the most exciting or encouraging color, followed by yellow and third as orange. Blue, white and green were mentioned as the calmest colors. The distribution of associated emotional qualities to individual colors proved to be very uneven in all research. Certain affective contents are associated with certain colors more often, while with other colors only rarely [7].

2-2- Research of Biological Rhythms

In the last 40 years, biological rhythm research has shifted from the shadows of mysticism to the widely recognized biological and neurobiological sciences, including chronobiology and numerous sleep research [35]. In psychology, research on rhythmicity faces a number of methodological difficulties. Rhythmicity in performance and experience is influenced by a number of other factors, including the influence of learning, levels of motivation, validity and reliability of test methods used, intervals between individual measurements and especially belonging to morning and evening chronotypes [8].

The early period of research was started in 1885 by Ebbinghaus [36], who in his experiments investigated the effect of the day time on the time needed to memorize a list of meaningless syllables. In 1887, Lombard [37] studied the change in the intensity of the patellar reflex during the day. In the twentieth century, there was a great development of research in the field of biological rhythms and their effect on various psychological and behavioral properties. In 1937, the Society for the Research of Biological Rhythms was established, later in the 1970s, the professional periodicals Chronobiology and the International Journal of Chronobiology were established in the United States, which began to address this particular research area [35]. With the rise of air transport, research has focused on the problem of the effect of the phase shift of the internal biological clock on the performance and health of pilots and passengers, the so-called jet lag syndrome [8]. Zonal disease causes a total disorientation due to desynchronization between the old biorhythms of the body and the synchronizers of the new time zone. Shift work can cause similar symptoms [38]. An extraordinary benefit was the research in time isolation, where the subjects did not have information and data about the current time. They lived for several weeks in stable laboratory conditions with the ability to freely control their daily routine [8].

As stated by Nimrod [39], day people are most alert in a daylight, night people at dusk. Even before specific scientific research, people themselves observed that some preferred activity in the morning and during the day and others later in the afternoon and at night. The individual difference in circadian rhythmicity is the belonging to chronotypes. In principle, individuals can be divided into three categories in terms of time of day preference for morning, neutral or evening chronotype. Diurnal preference, depending on the preferred time of day at which an individual delivers optimal performance, represents a continuum from extremely morning to extremely evening [8]. Morning chronotypes achieve maximum performance and subjective activation in the morning, while evening chronotypes in the afternoon and evening. Neutral chronotypes can flexibly adapt to the required rhythm of an activity [40]. The "Morningness / Eveningness Questionnaire" (*MEQ*) by Horne and Őstberg [41], which was also validated for the Czech environment [8], is most often used to divide individuals to a certain chronotype.

Individuals differ in their preferred mode of sleep and wakefulness, as well as the course of the body temperature, behavior and emotion curve [42]. Key objective indicators of morning / evening preference include the assessment of the phase of biological rhythms. The morning and evening chronotypes of individuals demonstrably differ in the rhythm of basal temperature by an average of about two hours, in the rhythm of melatonin and cortisol excretion. These differences persist even when members of the morning and evening chronotypes in laboratory conditions follow the same sleep pattern.

Studies Escribano [43] and Vink et al. [44] have shown that diurnal preference is 45-55% inherited and probably related to CLOCK gene polymorphism. Of course, the education, environment and culture in which the individual lives has a significant influence. According to some studies, belonging to a certain chronotype is determined by the season of birth [8]. Especially men born in autumn have a higher morning preference than individuals born in spring and summer. According to Wallace [45], whether an individual is of the morning or evening chronotype, it is also affected by the hour of birth; people born during the day tend to be early chronotypes, while individuals born at night tend to be evening chronotypes.

The general daytime performance curves for all chronotypes of tasks are misleading, regardless of the individual's differences. Depending on the chronotype of the individual, his performance curve also varies over time. The research of the presented work is based on this assumption.

3- Materials and Methods

The flowchart of the research methodology that was used to achieve the study's aims is shown in Figure 1.

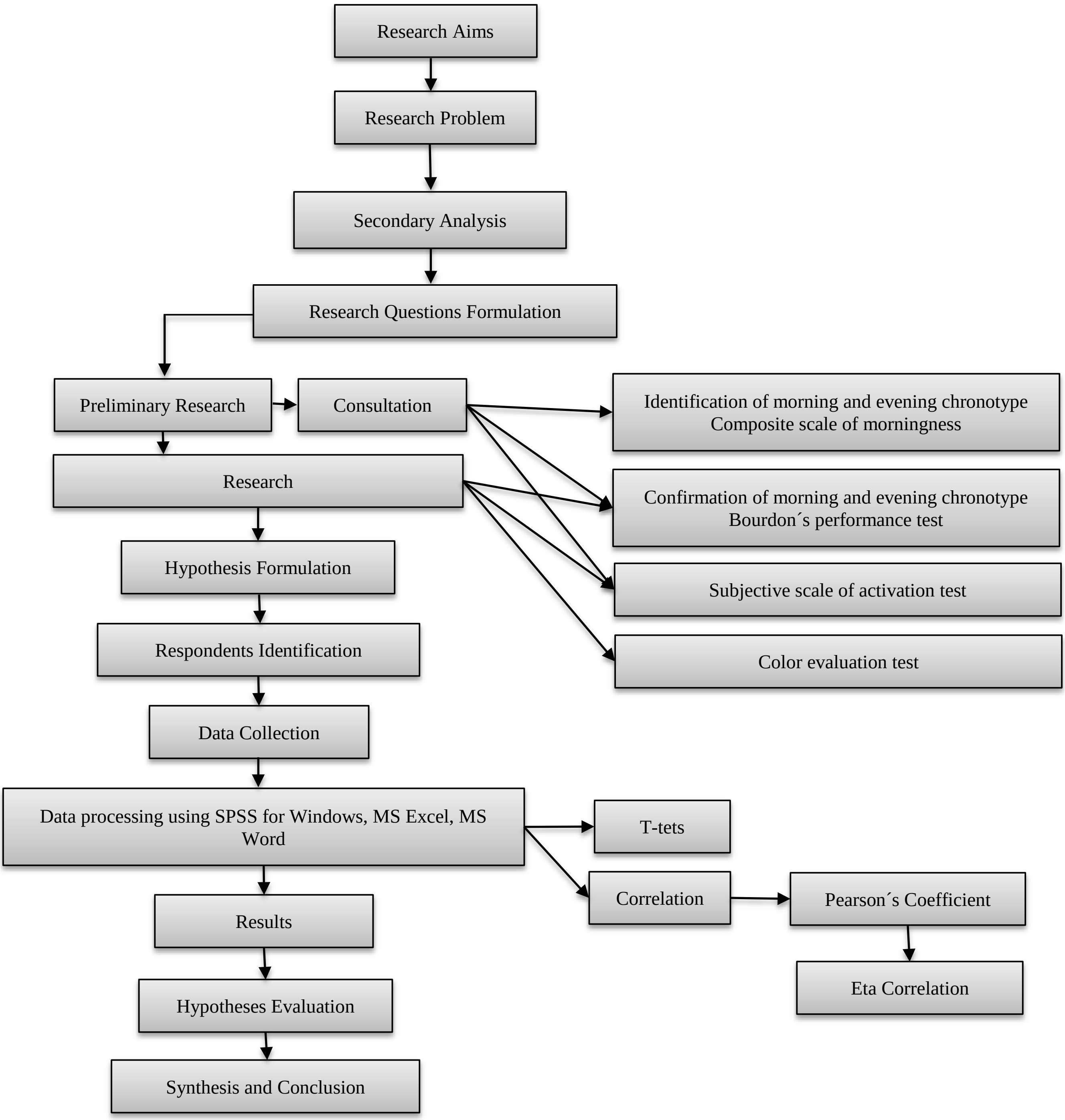

Figure 1. Flowchart of the research methodology

3-1- Research Objective

In connection with the diversity of studies performed on colors in general, preferences and color associations and also in connection with the critique of their validity and the generalization of their conclusions, we decided to deal in the research with the topic of color associations. Color and their meaning correlations, i.e. the creation of an association, we based on the existence of a physiological variable, namely the psychophysiological condition. As indicated in the introduction, this paper aims to empirically identify and verify the presumed correlation between the circadian rhythm phase and color evaluation.

Psychophysiological status represents the belonging to the morning or evening chronotype in research. In the study, we assess the influence of the circadian rhythm phase, based on belonging to a given chronotype, on the color association in terms of the activity-attenuation dimension. The aim of the research is to find out which colors can be marked on the basis of the association of the current psychophysiological state of the respondents as colors associated with activity and agility, and which, on the contrary, with attenuation and fatigue.

3-2- Research Procedure

The basis of the research is the use of particular differences in biological rhythms in individuals. Using a test Composite Scale of Morningness – CSM by Smith et al. [46], only such persons, who met the characteristics of the morning or evening chronotype, preferring a period of performance between 8 and 10 or 19 and 21 hours, were addressed for further research. Neutrons were not included in the study.

The other three tests were performed by the respondents twice in one day, in the morning and in the evening.

For authorization and confirmation of belonging to a given chronotype, respondents were subjected to Performance tests focused on attention. This test was invented by Bourdon in 1895 and his version valid for Czech and Slovac Republic was published in Kuruc et al. [47].

According to the correctness of the filling and the final time in both tests, the respondents who achieved better performance in their rhythmic phase of attenuation were further excluded. Specifically, this meant that if the subject of the morning performance chronotype had better results of the performance test in the evening, he was discarded, and vice versa.

To confirm the required psychophysiological state of alertness and fatigue, the respondents also filled in a Subjective scale of activation test (see Table 1), on which they used values to characterize their mental state. If the subjective performance status did not correspond in time to the given chronotype of the examined person, it was excluded from the sample.

The respondents finally completed a color evaluation test based on research by Goethe and Luscher [48] and confirmed by Roubíčková (2008) [51]. On the scale for each color, respondents recorded a value that describes the degree of their choice of a given color at a given time in relation to their physiological condition, so they rated each color according to how it describes their condition.

The research took place without the control of the administrator in the natural environment of the respondent.

3-3- Preliminary Research

The preliminary research was carried out with the help of 16 people, 6 boy students, 5 girl students from DTI University and 5 company employees. When preparing the overall questionnaire, we consulted each partial test. The scales were about understanding the statements made, the color test was about making the instructions clear and the optimal length of the performance test.

After interviews with preliminary research respondents, we chose research without the presence of an administrator, i.e. without control. This was mainly due to the set times for completing the tests, which were between 8 and 10 o'clock in the morning and 19 and 21 o'clock in the evening. We thus preferred the natural environment in which the subjects participated in the research.

For the composite scale of morning and evening chronotypes and the subjective scale of activation, we verified the understanding of individual questions and statements. It was marked as seamless.

When choosing a suitable performance test, we counted on its separate administration and we focused mainly on its length. Based on tests of different lengths with different numbers of tasks and preliminary research respondents' reactions to them, we determined the optimal test length so that the test is not too short, i.e. so that the measured time is authoritative, and at the same time too long so that respondents do not start bothering tasks. Finally, based on the assumption of fatigue monitoring, we chose attention tests as the most appropriate. Depending on the times of the people who participated in the preliminary research, we assumed a time to complete the tasks of approximately 8 - 17 minutes.

3-4- Variables, Research Question, Formulation of Hypotheses

In the study, it is necessary to empirically verify the assumed correlation between independent and dependent variables and to verify the assumptions. As an independent variable, the research determines the diurnal preference, which is reflected in the research by the current performance psychophysiological state of the examined persons. The current status is being resolved in research based on the Composite scale of the morningness, Bourdon´s performance test and Subjective scale of activation test. The psychophysiological state in this research thus acquires two opposite poles. In the first case it is a mental and physical state and a feeling of activity, alertness or readiness for activity, in the second case it is a state of fatigue, depression, drowsiness or passivity.

The dependent variable is the color rating. In the research, the evaluation of colors is performed for each of the eight submitted colors using an evaluation scale, on which each respondent recorded how the said color describes his psychophysiological state.

Based on the aim of the research, we determined this research question:

Are there differences between colors that are associated with a state of performance and alertness based on the psychophysiological state and, conversely, colors that are associated with a state of dampness and fatigue?

Based on the results of available studies, for example Zerbini & Merrow [49], and Rosenberg et al. [50], we have formulated the following hypotheses:

H0: There is no correlation between psychophysiological condition and color choice.

H1: Based on the distinction between the psychophysiological state of morning and evening chronotypes, there are differences between the morning choice and the evening choice of colors as colors describing the current state of the respondents.

During a circadian rhythm, a person's body temperature, performance, activation, subjective alertness, hormone levels, attention, mood, or perception change during a day [8]. Based on the above assumptions, respondents will choose colors related to their current state differently at specified times according to the color test assignment.

H1a: Respondents belonging to the group of morning chronotypes choose a different color in the morning to express their condition than in the evening.

H1b: Respondents belonging to the group of evening chronotypes choose a different color in the morning to express their condition than in the evening.

With regard to the research Jiang et al. [11], and Baniani & Yamamoto [12], we assume that the colors characterizing the state of higher activity and agility should include red, orange and yellow, the state of damping and fatigue is characterized by blue and green.

H2: In terms of diurnal preference, there are differences between respondents from the two groups of chronotypes (morning and evening) in the choice of colors in the morning and in the evening.

Based on belonging to a given chronotype, the individual prefers a certain time of day in which he gives optimal performance. Morning chronotypes achieve maximum performance and subjective activation in the morning, while evening chronotypes in the afternoon and evening. The evaluation of individual colors of persons belonging to morning or evening chronotypes will differ from each other.

H2a: When choosing in the morning, the groups of respondents of morning and evening chronotypes will differ in their color ratings.

H2b: When choosing in the evening, the groups of respondents of morning and evening chronotypes will differ in their color ratings.

Additional research question: Are there differences between a group of morning and evening chronotypes when choosing colors in their active rhythmic phase and attenuation phase?

3-4-1- Intervening Variables

The presence of the administrator during the completion of the tests, therefore the control in this research was missing. Because of this, we could not be 100% sure of following the instructions correctly. We met the respondents in person before the research, discussed the instructions with them and answered the questions they asked. We also asked them to follow the procedure exactly, with an emphasis on meeting the completion times.

On the other hand, the absence of a controller excluded the influence of his presence, which can be disruptive and which we considered invasive in this research. We preferred natural conditions, especially in the form of the place where they filled out the tests, where, given the specified times, the home environment prevailed.

In psychological research of colors, lighting conditions are an important variable; different lighting (daylight, direct sunlight, artificial lighting) can affect and change the display of colors. Due to the specified test administration times, it was difficult to ensure constant lighting conditions. Respondents were asked not to judge colors in direct sunlight.

To check the learning effect in the Bourdon´s performance test, the test variants were systematically divided within groups of respondents. In the Color evaluation test, the fixed order of the presented colors in a row was not determined. The colors were presented to each subject in a different order to exclude the effect of order.

Personal sympathy and antipathy to certain colors may have influenced color ratings. In connection with the association of colors, it is necessary to take into account the possible influence of individual experiences of the respondents, cultural influences or knowledge of the psychology of colors. Other characteristics can affect color evaluation, such as personality, current mood, activities that preceded the tests.

Due to the deliberate influence of their own results, the respondents were not informed of the aim of the research in advance, so they did not know exactly what it was and how they should answer correctly. Persons who consumed alcohol or other narcotics were excluded from the research.

3-5- Research Sample

When selecting respondents, the basic indicator was the limited age from 20 to 40 years. This limitation was based on the above conclusions of research on biological rhythms - with age, the biological rhythms of individuals change, as well as during adolescence. Eyesight also deteriorates with age, and some authors, such as [52], state that color perception also changes. The selection was focused on both men and women. To ensure a certain homogeneity of the sample, we focused on the selection of respondents at students of the DTI University in Dubnica nad Váhom, Slovakia, and academic and technical-economic staff of this school. We have deliberately excluded people who have connections to psychology, color psychology, design, fashion design etc.

Other conditions were the absence of any color perception disorder and sleep disorders. The respondent was not allowed to be under the influence of alcohol or other drugs at the time of the research and also to be sick.

A total of 720 people were included in the research. Of this number, 330 were women and 390 were men. The age of the subjects ranged from 20 to 40 years. The mean age of all subjects was M = 28.2 years with a standard deviation of SD = 5.92. The morning chronotype had 400 subjects and the evening chronotype 320.

Based on the results of the Bourdon´s performance test, four people were excluded. One subject was excluded based on the responses of the Subjective scale of activation test. One subject was excluded from the sample due to problems with the resolution of green and red, thus the possible occurrence of a color cell disorder - dichromatism. Another subject was excluded from the research sample due to higher alcohol consumption the previous day. Three respondents were excluded for not complying with the time conditions for completing the tests, to which they subsequently confessed after suspicion.

The research sample was obtained through occasional selection based on the availability of people and their willingness to participate in the research. During the search for suitable respondents, the snowball method was also used, where the addressed persons passed on a range of morning and evening chronotypes to their classmates or colleagues from work. From the overall point of view, the reluctance of people to participate prevailed when addressing people, justified mainly by the lack of time. It should be noted that the methods used to select the subjects are unreliable to ensure representativeness. They do not allow for a broad generalization of conclusions, but this does not mean that the results obtained and the conclusions reached are not useful.

3-6- Data Collection

Data collection took place from the second half of March to the end of April 2021. In March, potential respondents with a composite range of morning and evening chronotypes were addressed. On the basis of its completion and fulfillment of the requirements for inclusion in the research sample, the persons willing to cooperate were given tests in printed form in April. At the same time, they were given specific instructions for filling in with a request to return the completed tests by 27 April 2021. Tests returned by April 28, 2021 were included in the research.

3-7- Methods Used

The research consisted of four parts. In the first phase, the affiliation of the respondent was determined to the morning, neutral or evening chronotype according to diurnal preferences, for which the Composite Scale of Morningness was used. This scale was chosen mainly for the optimal length of the questionnaire, high reliability and good psychometric properties, which were also verified in its Czech version. Belonging to a given chronotype was then further verified by Bourdon´s performance test and a Subjective scale of activation tests. In the last phase, respondents completed a Color evaluation test.

3-7-1- Composite Scale of Morningness - CSM

The standardized method for determining the morning and evening preferences *Composite Scale of Morningness* (CSM) comes from [46]; it includes 13 questions. The questionnaire was translated into Czech by Skočovský [8], who also tested the psychometric properties of the translated version and came up with values that are comparable to foreign results.

In the thirteen items of the questionnaire, respondents have a choice of four to five variants of answers. The questions concern bedtime, getting up and time of the day performance. Individuals who gain 13 - 26 points belong to the evening chronotype, 27 - 41 points indicate a person of the neutral chronotype and 42 - 55 points indicate a person to the morning chronotype.

Based on the CSM, the time to complete the questionnaires was also determined. According to question number eight, which determines the most suitable time for the peak of one's own performance, the time for completing the tests was limited to 8-10 o'clock in the morning and 19-21 o'clock in the evening.

The CSM was passed on to the respondents without the given point evaluation, so they were not affected by a specific number indicating the number of points after each statement, and throughout the research they did not know the chronotype of the results.

3-7-2- Bourdon´s Performance Test

The Bourdon´s test makes it possible to determine individual performance in terms of attention and concentration. Processing speed, compliance with rules and quality of the performance in distinguishing similar visual stimuli are measured. Šnýdrová [53] lists the strike test as a typical tool for attention tests. It was founded in 1898 and has undergone many modifications since then. The method offers more administration options. The validity of the strike test was verified on a set of 1,020 individuals based on a comparison with other methods. The aim in completing the strike test was to mark the specified symbols as quickly and correctly as possible (without error) without a time limit.

Two versions of the tests were used, each consisting of a classic strike test and a pairing test. The task of the respondent was to go through all the lines in the strike test and in the first variant to strike the letters "d" and "v", in the second variant the numbers "4" and "9".

In the pairing test, the respondents had the task in the first variant in each section on all lines to find and mark pairs of adjacent numbers, the sum of which was 10. In the second variant, they marked pairs of letters in the alphabet in a row.

These are two slightly different tests, which determine the level of intentional attention, accuracy of perception, work psychomotor pace, as well as performance capacity. The difference between tasks and symbols is created to mitigate the learning effect that needs to be taken into account in research. Therefore, the variants of performance tests among respondents were systematically distributed so that half of the respondents with a relative regard to the division between morning and evening chronotypes had the first variant in the morning test, half in the evening. Furthermore, the respondents were divided into a group that started the research with a morning test and a group that started with an evening test.

The evaluation of tests was not limited by a time limit, on the contrary, the time limit was one of the performance indicators. When evaluating the tests, the correct answers were registered as well as incorrect ones. Wrong answers included mislabeled symbols and omitted unlabeled symbols.

3-7-3- Subjective Scale of Activation Test

The subjective scale of activation included five bipolar statements about the current mental state (Table 1). It is a complex methodological tool on which the respondent records his current mental state. Each statement has a scale with a range of 11 points. This scale determines the subjective evaluation of the current activation of the examined persons

Table 1. Subjective scale of activation test

I am sleepy	1 2 3 4 5 6 7 8 9 10 11	**I feel fresh**
I feel exhausted	1 2 3 4 5 6 7 8 9 10 11	**I feel I have enough energy**
I concentrate well	1 2 3 4 5 6 7 8 9 10 11	**I can't concentrate**
I feel like going to some activity	1 2 3 4 5 6 7 8 9 10 11	**I don't want anything**
I'm tired	1 2 3 4 5 6 7 8 9 10 11	**I'm rested**

In connection with the monitoring of biological rhythms, self-assessment scales focus on the characteristics of alertness, activity, fatigue and drowsiness. The methods used include, for example, the Stanford somnolence scale or the modified *Visual Analogue Scale* [54]. The subjective scale of activation test is a simplified form containing only five statements that relate to fatigue.

The individual statements are intentionally made irregularly, so the three points had to be overturned. Based on this, the respondent can get from 6 to 55 points, where the state of fatigue, drowsiness and exhaustion increases towards six points and the state of sufficient energy, rest and activity towards sixty-six points. If an individual ticked a neutral value for each answer, he would achieve 30 points. The prerequisite was therefore to gain more than 30 points in its rhythmic active phase and less than 30 points in the rhythmic phase of attenuation. Limits 6 - 20 and 40 - 55 were set for the inclusion of the respondent in the sample.

3-7-4- Color Evaluation Test

The choice of specific colors and shades was within our competence due to the diversity of previous research designs and the focus of our research. From the results of the preliminary research, we determined the number of eight colors as suitable, while we tried to cover the color space as appropriately as possible.

When choosing specific colors for the color test, we based on several assumptions and resources. The first source was the basic colors based on Goethe's color circle. We chose the RYB model (red - yellow - blue), which contains the primary colors - yellow, red and blue. By mixing them, the secondary colors orange, purple and green are created. These six colors are also the colors of the rainbow. The choice of primary colors is based on research findings that primary colors are generally more popular than other mixed color tones [7]. The basis for the choice of colors were therefore these six standard colors from the color spectrum.

Another source in color choice was the Lüscher color test. The specific color shades for this test were selected specifically for personality diagnostics, so we did not use them all for our color test. We used gray and brown. In determining the specific color shades, we used the basic 16 displayed html colors and the computer standard for computer imaging technology VGA. Color shades were defined with 100% RGB saturation in Adobe Photoshop CS.

Colored squares with an edge of approximately 4.5 centimeters were created, following the pattern of the Lüscher color test, as well as a white background. Each color square was printed on separate paper on the HP Color LaserJet 2605dtn printer. The order of colors in the tests in succession was created randomly in different variants, to exclude the influence of the order of colors on their choice.

3-8- Method of Data Processing

The obtained data were processed in the program SPSS for Windows, version 12.0. "Frequencies" procedures were used to determine the basic distributions of values in the research sample. MS Excel and MS Word were used to create graphs and tables. T-tests for paired data were used to compare data within one group of respondents. The morning and evening groups were compared using t-tests for independent sampling. Finally, correlations were made between the choice of colors by bivariate analysis, specifically the Pearson coefficient, and the results of t-tests were supplemented by the correlation Eta.

4- Findings and Discussion

4-1- Total Values of Analysed Variables and the Hypothesis Evaluation

Before a statistical comparison of the two groups of respondents, we present the diameter of the choice of individual colors.

Table 2. Frequencies of choice of individual colors, standard deviations and diameter of choices of colors of morning chronotypes in the morning

	Yellow	Orange	Red	Purple	Blue	Green	Brown	Grey
1	1	0	1	3	6	3	15	15
2	0	2	4	12	8	8	8	15
3	1	2	7	9	13	6	10	6
4	9	7	4	13	8	9	3	1
5	9	16	11	1	2	10	2	2
6	10	10	8	2	3	4	2	1
7	10	3	5	0	0	0	0	0
Diameter	**5.38**	**4.97**	**4.60**	**3.08**	**3.03**	**3.68**	**2.38**	**3.08**
Standard deviation	1.37	1.12	1.65	1.23	1.39	1.49	1.44	1.23

Respondents belonging to the group of morning chronotypes, in connection with their performance status, most often chose the colors yellow, orange and red in the morning. The yellow color was ranked the most, the choice of yellow in the range of 1 - 3 was made by only two respondents. On the contrary, both extreme values 6 and 7 were chosen by half of the respondents. Gray and brown were chosen the least on the scale. The values of standard deviations showed that the respondents chose the individual colors relatively consistently, i.e. they did not differ much from each other in their choices.

Table 3. Frequencies of choice of individual colors, standard deviations and diameter of choices of colors of morning chronotypes in the evening

	Yellow	Orange	Red	Purple	Blue	Green	Brown	Grey
1	14	5	6	2	0	0	2	4
2	11	12	11	0	0	1	8	3
3	9	18	16	3	2	2	7	3
4	4	3	7	13	4	7	7	7
5	1	1	0	13	12	17	11	10
6	1	0	0	8	13	9	3	11
7	0	1	0	1	9	4	2	2
Diameter	**2.25**	**2.68**	**2.60**	**4.58**	**5.58**	**5.08**	**3.85**	**4.43**
Standard deviation	1.26	1.41	0.96	1.26	1.11	1.12	1.58	1.72

The evaluation of colors in the evening for respondents of the morning chronotype shows a preference for blue, followed by green and purple. On the contrary, in the morning choice highly rated yellow, orange and red are now at the opposite end. The standard deviations are again relatively low, the largest differences between the respondents' choices can be seen in the color gray and brown.

H1a: *Respondents belonging to the group of morning chronotypes choose a different color in the morning to express their condition than in the evening.*

Table 4. T-test results for paired color selection data for morning chronotype in the evening and in the morning

		Pair differences				t	df	Sig.
		Average difference	Standard deviation	The 95% confidence interval of the difference				
				low	upper			
pair 1	**Yellow**	3.13	2.07	2.46	3.79	9.60	39	0.01
pair 2	**Orange**	2.30	1.70	1.76	2.84	8.57	39	0.01
pair 3	**Red**	2.00	1.85	1.41	2.59	6.83	39	0.01
pair 4	**Purple**	-1.50	1.75	-2.06	-0.94	-5.41	39	0.01
pair 5	**Blue**	-2.56	1.84	-3.14	-1.96	-8.78	39	0.01
pair 6	**Green**	-1.40	2.02	-2.05	-0.75	-4.38	39	0.01
pair 7	**Brown**	-1.48	2.11	-2.15	-0.8	-4.42	39	0.01
pair 8	**Grey**	-2.35	2.01	-2.93	-1.71	-7.41	39	0.01

To test the first hypothesis, the morning and evening color choices of the morning chronotypes were compared. A paired data t-test was used to compare the averages of two variables in one group.

For all colors, the difference between the respondents' choices in the morning and evening is statistically significant at the 1% level ($p = 0.01$). The hypothesis was therefore confirmed. Yellow, orange and red gained a higher value in the morning, the other colors in the evening. All differences are relatively high, the most significant is the difference in yellow and the significantly higher values in the morning were obtained by orange and red and vice versa significantly higher values in the evening were obtained by color blue and gray.

We also present the results of the choice of colors of the respondents from groups of evening chronotypes. These respondents chose mostly gray in the morning as a color that captures their current status. Blue and green followed with the same average values. In the last places there were chosen orange, yellow and red. The values of standard deviations showed that the respondents again chose the individual colors relatively consistently, the choices of the orange color differed the least, the green color the most.

Evening chronotypes in the choice of colors clearly preferred red in the evening, the average value of 5.75 is also the highest of all four color choices made by respondents in the research. On the other hand, brown with an average value of 1.88 is the choice with the lowest average value of all the choices made. Red is followed by orange and blue. The brown and gray color occurring at the end of the evaluation have the lowest standard deviations in this selection. On the contrary, the respondents deviated the most when choosing the blue color, which has a higher standard deviation, namely 2.33.

Table 5. Frequencies of choice of individual colors, standard deviations and diameter of choices of colors of evening chronotypes in the morning

	Yellow	Orange	Red	Purple	Blue	Green	Brown	Grey
1	10	3	10	3	0	0	1	0
12	11	14	2	5	2	1	0	1
30	6	12	5	7	4	9	10	3
410	4	2	5	12	8	3	12	5
512	1	1	0	3	8	8	7	6
6	0	0	0	2	5	5	1	10
7	0	0	0	0	5	6	1	7
Diameter	**2.22**	**2.50**	**2.16**	**3.41**	**4.78**	**4.78**	**3.97**	**5.31**
Standard deviation	1.13	0.88	1.05	1.32	1.45	1.56	1.12	1.40

Table 6. Frequencies of choice of individual colors, standard deviations and diameter of choices of colors of evening

	Yellow	Orange	Red	Purple	Blue	Green	Brown	Grey
1	0	0	0	5	6	1	13	7
12	4	0	1	8	6	9	10	11
30	9	1	0	9	0	8	9	10
410	8	7	5	7	0	7	0	4
512	8	9	6	3	7	7	0	0
6	2	9	8	0	6	0	0	0
7	1	6	12	0	7	0	0	0
Diameter	**3.94**	**5.38**	**5.75**	**2.84**	**4.31**	**3.31**	**1.88**	**2.34**
Standard deviation	1.27	1.13	1.30	1.22	2.33	1.20	0.83	0.97

H1b: Respondents belonging to the group of evening chronotypes choose a different color in the morning to express their condition than in the evening.

Statistically significant differences between the morning and evening color choices of the evening chronotypes occurred in yellow, orange, red, green, brown and gray at the 1% level of significance. For the first three colors mentioned, the value of the choices is higher in the evening and for the remaining three colors in the morning. Respondents statistically significantly preferred the choice of purple in the morning, here on the border 5% level of significance. The difference in the choice of blue in the morning and evening was not statistically significant. The hypothesis was therefore confirmed for all colors except blue.

For comparisons between groups of morning and evening chronotypes, we used a t-test for two independent samples along with Leven's test of agreement of variances, which indicated whether or not to use a modification of the t-test for unequal variances.

Table 7. T-test results for paired color selection data for evening chronotype in the evening and in the morning

		Pair differences				t	df	Sig.
		Average difference	Standard deviation	The 95% confidence interval of the difference				
				low	upper			
pair 1	**yellow**	1.72	1.80	1.07	2.37	5.40	31	0.01
pair 2	**orange**	2.88	1.6	2.28	3.47	9.91	31	0.01
pair 3	**red**	3.59	1.76	2.95	4.23	11.45	31	0.01
pair 4	**purple**	-0.56	1.52	-1.11	-0.01	-2.09	31	0.05
pair 5	**blue**	-0.47	2.63	-1.42	0.48	-1.01	31	0.32
pair 6	**green**	-1.47	1.81	-2.12	-0.82	-4.58	31	0.01
pair 7	**brown**	-2.09	1.40	-2.60	1.59	-8.46	31	0.01
pair 8	**grey**	-2.97	2.09	-3.72	-2.22	-8.05	31	0.01

4-2- Groups Comparison

For comparison between groups of morning and evening chronotypes, we used a t-test for two independent selections at the same time as Leven's test of agreement of variances, which indicated whether to apply the modification t-test for unequal variances or not.

H2a: When choosing in the morning, the groups of respondents of morning and evening chronotypes will differ in their color ratings.

Table 8. T-test results for paired color selection data for morning and evening chronotype in the morning

	Pair differences				t	df	Sig.
	Average difference	Standard deviation	The 95% confidence interval of the difference				
			low	upper			
Yellow	3.16	0.30	2.56	3.76	10.48	70.00	0.01
Orange	2.48	0.25	1.97	2.98	8.93	70.00	0.01
Red	2.44	0.32	1.81	3.08	7.65	66.99	0.01
Purple	-0.33	0.30	-0.93	0.27	-1.10	70.00	0.27
Blue	-1.76	0.34	-2.43	-1.09	-5.23	70.00	0.01
Green	-1.11	0.36	-1.83	0-.39	-3.06	70.00	0.01
Brown	-1.59	0.30	-2.20	-0.99	-5.27	69.95	0.01
Grey	-3.24	0.31	-3.86	-2.62	-10.44	70.00	0.01

Statistically significant differences between the choice of morning and evening chronotypes in the morning occurred for all colors except purple. The hypothesis is therefore confirmed for all colors except purple. The highest differences were between the yellow, orange and red choices, at the 1% level of significance. Morning chronotype respondents rated these colors as the ones that best describe their condition. The remaining colors (except purple) better describe the condition of the evening chronotype respondents, these respondents chose the gray color significantly more.

H2b: *When choosing in the evening, the groups of respondents of morning and evening chronotypes will differ in their color ratings.*

Table 9. T-test results for paired color selection data for morning and evening chronotype in the evening

	Pair differences				t	df	Sig.
	Average difference	Standard deviation	The 95% confidence interval of the difference				
			low	upper			
Yellow	-1.69	0.30	-2.28	-1.09	-5.64	70.00	0.01
Orange	-2.70	0.27	-3.24	-2.16	-10.02	70.00	0.01
Red	-3.15	0.27	-3.68	-2.62	-11.87	70.00	0.01
Purple	1.73	0.29	1.14	2.32	5.88	70.00	0.01
Blue	1.26	0.45	0.36	2.17	2.82	42.07	0.01
Green	1.76	0.27	1.22	2.31	6.42	70.00	0.01
Brown	1.98	0.29	1.40	2.55	6.82	61.51	0.01
Grey	2.08	0.32	1.44	2.72	6.46	63.51	0.01

The same hypothesis is also tested for evening color choices for morning and evening chronotypes. Respondents of the evening chronotype statistically significantly preferred yellow, orange and red as the colors describing their state in the evening. Other colors, on the other hand, statistically significantly favored the morning chronotypes. All differences are significant at the 1% level, the difference in the choice of red dominates the most.

Additional research question**:** *Are there differences between a group of morning and evening chronotypes when choosing colors in their active rhythmic phase and attenuation phase?*

To complement the testing of the second hypothesis, the difference between the choices of morning chronotypes in the morning and evening chronotypes in the evening (i.e. in the expected more active phases) was also tested. Therefore, based on the hypothesis, there should be no difference here.

There are no statistically significant differences for orange, purple, green, brown and gray.

Statistically significantly, the respondents differed in the choice of yellow, red and blue. However, the differences are not really high, the highest difference is 1.44 for yellow.

Table 10. T-test results for independent selections for morning and evening chronotypes when choosing colors in more active rhythmic stage

	Pair differences				t	df	Sig.
	Average difference	Standard deviation	The 95% confidence interval of the difference				
			low	upper			
Yellow	1.44	0.31	0.81	2.07	4.57	70.00	0.01
Orange	-0.40	0.28	-0.95	0.15	-1.45	70.00	0.15
Red	-1.15	0.36	-1.86	-0.44	-3.23	70.00	0.01
Purple	0.23	0.29	-0.35	0.81	0.80	70.00	0.43
Blue	-1.29	0.47	-2.23	-0.35	-2.76	47.94	0.01
Green	0.36	0.33	-0.29	1.01	1.11	70.00	0.27
Brown	0.50	0.27	-0.04	1.04	1.84	64.20	0.07
Grey	-0.27	0.27	-0.80	0.26	-1.01	70.00	0.32

Differences in the choice of colors in the phase of lower activity were also tested in both groups of respondents, i.e. in the morning chronotypes in the evening and in the evening chronotypes in the mornings.

There are no statistically significant differences in yellow, orange, red, green and brown. Statistically significantly, the respondents differed in the choice of purple, blue and gray. However, the differences are again not very high, the highest difference is 1.17 for purple.

Table 11. T-test results for independent selections for morning and evening chronotypes when choosing colors in lower rhythmic stage

	Pair differences				t	df	Sig.
	Average difference	Standard deviation	The 95% confidence interval of the difference				
			low	upper			
Yellow	0.03	0.28	-0.54	0.60	0.11	70.00	0.91
Orange	0.18	0.25	-0.31	0.66	0.71	70.00	0.48
Red	0.44	0.24	-0.03	0.92	1.87	70.00	0.07
Purple	1.17	0.30	0.56	1.78	3.84	70.00	0.01
Blue	0.79	0.30	0.19	1.40	2.63	70.00	0.01
Green	0.29	0.33	-0.36	0.95	0.90	54.41	0.37
Brown	-0.12	0.32	-0.75	0.52	-0.37	69.12	0.71
Grey	-0.89	0.38	-1.64	-0.14	-2.36	70.00	0.02

4-3- Additional Analysis

To supplement the hypotheses, Pearson's correlation was made between the evaluations of individual colors within one of each of the choices made by the respondents. Below there are the correlations for morning chronotypes in choosing colors in the morning.

Statistically significant correlations exist when choosing red and yellow, red and orange. If the respondent rated red more, he also rated yellow and orange more. Furthermore, if the respondent rated brown below, he also rated gray, blue and purple below. Conversely, if the respondent's condition was better described by yellow, he was less described by purple, blue, green, brown and gray. It is also possible to observe negative correlations of orange and brown and red with purple, brown and gray. The correlations are moderately strong.

We also evaluate the correlations for morning chronotypes in the choice of colors in the evening. If the respondent rated less red, he rated less in this connection orange as well. If he rated blue more, so he did green and purple. If he gave a lower value to yellow, the higher value was given to blue and green. There is also a negative correlation between red and green. The correlations are moderately strong.

The choice of orange and yellow is very strongly related to the morning choice of evening chronotypes; this correlation is relatively high (0.70). The less respondents chose orange, the more they preferred blue. There is also a negative correlation for brown and red, surprisingly with respect to the overall averages there is a negative correlation for gray and blue. If the gray color described the respondent's condition more, then also brown, less it described the red one. There is also a positive correlation between blue and green. For the evening choice of evening chronotypes, there is a stronger correlation between the choice of red and orange. Other correlations are negative. If respondents chose more red, the chose less gray and purple. They also rated the gray color less with a higher rating of orange. The correlation also occurs for green and purple.

In addition to t-tests, the strength of the correlation between color choice and chronotype was also determined. That is, how strongly relates whether a person is a morning or evening chronotype, and what color he chooses in the morning and in the evening. The variable "chronotype" is dichotomous and difficult to create a correlation, however we choose the coefficient Eta, which is recommended for this chronotype of correlation. However, this coefficient does not indicate the direction of the correlation. This can be deduced from other data. Pearson's Chi-square again shows the statistical correlations between color choice and chronotype.

The correlations complement the information on the differences in the choices from the t-tests and show that there is a strong correlation between which chronotype the respondent belonged to and how he ranked the individual colors. That is, except for those colors between which there were no statistically significant differences, which is purple in the morning choice. High correlations are captured between chronotype and yellow, orange and gray in the morning choice and orange and red in the evening choice (> 0.7).

Table 12. **Pearson's Chi-square and Eta**

	Pearson's Chi-square	Asymp. Sig.	Eta
	Morning		
Yellow	49,99	0,01	0,78
Orange	47,86	0,01	0,76
Red	35,36	0,01	0,66
Purple	3,33	0,65	0,13
Blue	22,86	0,01	0,53
Green	17,71	0,01	0,34
Brown	29,23	0,01	0,52
Grey	46,97	0,01	0,78
	Evening		
Yellow	24,80	0,01	0,56
Orange	52,54	0,01	0,77
Red	56,48	0,01	0,82
Purple	28,80	0,01	0,57
Blue	21,52	0,01	0,34
Green	27,62	0,01	0,61
Brown	31,03	0,01	0,61
Grey	32,49	0,01	0,59

4-4- Discussion

Based on the division of the examined respondents into clearly defined groups, the formulated research hypotheses were confirmed. The answer to the additional research question of whether there are differences between colors that are associated with a state of performance and alertness based on the psychophysiological state, and conversely with colors that are associated with a state of damping and fatigue, can be answered yes. From a broader point of view, it can be concluded that people attribute certain properties to individual colors, so there are psychic contents belonging to individual colors.

Using statistical processing, it was found that some differences in values between the choice of colors and the psychophysical state of the respondents were statistically significant. The correlation between the associated colors and the condition of the respondents was relatively strong with regard to psychological research. Based on knowledge from chronopsychology and determination using a Composite scale of morningness, it was assumed that the respondents from the group of morning chronotypes are alert in the morning, they are ready for activity, they are awake, active, full of strength, they do not feel tired or sleepy, they are focused. On the contrary, in the evening they feel tired, drowsy, they are not very focused, they are at rest, more passive, they have a lower level of activation, their attention is reduced.

For evening chronotypes, the expected state of higher activation was in the evening and the state of attenuation in the morning. The morning choice of respondents belonging to the group of morning chronotypes was considered as a state of higher level of activation. The color that best described this condition was yellow. Based on Jiang et al. [11], and Baniani & Yamamoto [12], red is the most often considered to be the most active color. But this color was ranked third in this choice. The second place in the evaluation was the color orange. Overall, the high evaluation of these three warm colors coincides with the results of the above cited research. On the contrary, gray and brown were marked as the lowest ranked colors, i.e. the colors that at least describe the condition of the respondents. The green and blue colors, most commonly referred to as the dormant and inactivity colors, ranked fourth and sixth.

More active state was also accompanied by the evening choice of respondents belonging to the group of evening chronotypes. The most ranked color in this choice was red, so it confirmed its importance of activity on the basis of the above cited research. Orange followed again in second place. Such an order corresponds to Lüscher's symbolism, in which his red-orange color is considered to be the most active. He attributes to it the meanings of force, impulses to action, driving force. In the choice of evening chronotypes, the warm yellow color was moved to fourth place by cold blue. Blue has been associated with arousal and stimulation in Schaie's study [30], so this result is not entirely surprising. The lowest rated colors are again brown and gray, only in the evening chronotypes they swapped the last and penultimate position.

The reasons that led the group of morning chronotypes to prefer yellow and, conversely, the group of evening chronotypes to prefer red, are unknown due to the quantitative implementation of the research and only at the level of speculation. Likewise, the third position of the color blue is an interesting result. If we consider the possible associations associated with it, for example, there is a very common association of yellow with the sun, which can mark the morning, the beginning of the day, which is a symbol of getting up and activity for the morning chronotypes. The preference for blue by evening chronotypes is accompanied by a high discrepancy in the choices of individual respondents. Some rated it as very highly describing their condition, others as very low, without neutral values. Blue can also be associated with night, darkness, for some associated with their nocturnal activity, for others a symbol of sleep.

The evening choice of respondents belonging to the group of morning chronotypes was characterized by a state of lower activation level. In this color assessment, blue was clearly preferred, followed by green, which confirmed the hypotheses. In the mentioned researches and the symbolism of colors, the color blue is most often a symbol of calm, passivity and attenuation. On the contrary, the lowest rated colors were yellow, red and orange, i.e. the highest rated colors of the active phase choice. The resting phase of the rhythm was also accompanied by a morning choice of colors for the evening chronotypes. In this color assessment, respondents clearly identified the gray color as the one that best describes their condition. They were followed by blue and green with the same average values. The least rated were red, yellow and orange. The reasons for preferring gray must again be accompanied by a note on the quantitative form of research with unknown causes for color evaluation. A certain explanation can be provided by the unpleasant morning getting up, which is accompanied by the evening chronotype and which the gray color can mark.

During the selection of morning and evening chronotypes, it could theoretically be assumed that the morning and evening choices for each group of respondents will differ mirrorly in the order of colors. This occurs mainly in both groups when choosing yellow, orange and red. In both less active phases of the rhythm, the color that occupies the first place in the active phase occurs at the last place of evaluation. For the morning chronotypes it is yellow and for the evening ones it is red, so these colors clearly represent two opposite poles. For other colors, a similar tendency is not visible. The evaluation of the gray color by evening chronotypes shows a similar direction, in the less active phase of the rhythm the color was ranked as the most descriptive state of the respondents, in the active phase it took the penultimate place.

Generally, yellow, orange and red appeared as a group of active colors together in the evaluation. In the evaluation, they have very similar results in all choices. The brown and gray colors appeared together in pairs when choosing the active colors at the opposite end, i.e. as colors that were evaluated as the least relevant to the active state of the respondents. When evaluating the colors in the less active phase of the respondents' rhythm, the brown color reached the center, so it did not copy its clear position. In these choices, complementary colors, such as green and red and blue and orange, also came into conflict with each other, which did not happen with active color choices, i.e. morning chronotypes in the morning and evening chronotypes in the evening. The purple color gained the most indifferent position, especially in the group of evening chronotypes.

As stated in the Introduction of this paper, color preferences for morning and evening chronotypes research has not been conducted often in recent years, it is rather a marginal topic. However, in the Czech Republic, research was conducted in 2008 as a part of Roubíčková's bachelor's thesis [51]. Based on her study, we state that our results are closely correlated with her results and that over time, there have been no fundamental changes in the perception of colors by individual chronotypes.

In our research, we focused on a very narrow topic, only on two dimensions of color associations "activity and passivity". When associating the correlation to color, these dimensions were currently present to each respondent, the respondent was in a state that he evaluated and to which he related individual colors. The above mentioned researches of color associations, e.g. Palmer & Schloss [4] and Veverková [7] usually work with a larger number of dimensions, when the examined persons choose colors which, according to them, describes these dimensions. In frame of one research, a much wider range of information and meanings is thus identified.

The disadvantage of this research is the relatively low efficiency of the extracted information in comparison with the number of applied methods before performing the Color evaluation test itself. Nevertheless, we preferred this form because we consider it important to associate colors directly with the given feelings, states and situations in which the individual finds himself, together with visual contact with the color.

We did not use any standardized method to evaluate colors, but we decided to use a rating scale for each color separately. However, a similar approach was used by Roubíčková [51]. The reason was to exclude forced choice, which is the case with the Lüscher test, for example. In this way of choosing colors, when the respondent is forced to sort the colors from the most popular to the least popular, there are interpretation problems with the colors that occupy the last places. Thanks to the scales used, respondents were able to clearly express and evaluate each color separately, which in our opinion had a higher informative value for this research.

There are significant limitations to the quantitative form of research. Just by checking the box next to the scale, the reason for preferring a certain color is not known, so each respondent can associate the color in a different way, and the researcher's reasons remain obscured. Qualitative research or, for example, just extending the original research with comments in which the respondent would explain why he evaluates the color in this way would help to identify the causes. However, the question remains whether the respondents are able to explain and justify their choice and association, or whether they only choose on the basis of emotion, previous experience, or other influences.

In connection with color associations, it is necessary to take into account the influence of personal experiences of the respondents, as well as the general influence of the environment and especially the previous influence and effect of colors. Associations can be formed on the basis of shared knowledge of basic knowledge of color psychology. Studies of color associations raise fundamental questions. Do color associations result from previous (unconscious) experience that people gain from the direct physiological action of colors? If colors act universally, as Lüscher [48] states, for everyone in the same way, then associations should be universally valid for all. Research on color associations should, therefore, in this respect, be linked to research into the physiological effects of colors.

When completing the tests, respondents stated that it was difficult for them to distinguish their relationship to color, i.e., how they liked the color and find an association with their own condition. Some respondents had a problem with the small size of the displayed colored squares. They stated that they had to look at the colors from an inch away to realize what color they were closest to, and the colors were more intense.

5- Conclusions

The results of the research mostly confirmed the established assumptions. The colors expressing activity included yellow, orange, and red, and the respondents from the group of evening chronotypes also included blue. Calm colors include blue, green, and gray. The most indifferent color was purple. The obtained results were statistically significant. There were also relatively strong correlations in the evaluation of colors due to the psychological focus of the research.

Objections concerning the validity of the research cannot be ruled out and must be taken into account. In particular, the presence of a controller during the research would be suitable for further research as well as the expansion of the research sample. Quantitative research on color association does not reveal the reasons and causes for the choice of colors, so in further research it is appropriate to focus on qualitative, methodologically accurate studies. As for the use of colors as psychodiagnostic aids, association research is of particular importance, as it is aimed at verifying the existence of a correlation between color and psychic content. If we find universal patterns in the psychic meanings of colors, we can manipulate them correctly and use them to our advantage. At the same time, however, color research leads us to question whether there are general rules of influence at all and the effect of colors and the universal psychic content associated with them.

This research can be a starting point, a lesson, or an inspiration for future studies on colors and their meaning in our lives. Based on our research, differences were identified not only in the evaluation of colors based on the psychophysiological state but also with respect to belonging to a given chronotype. Research in this direction can lead to many interesting results. For the use of color in psychodiagnostics, research on color associations is extremely important for verifying and searching for correlations between color and psychic content. If we know what the individual colors symbolize for individuals, we can manipulate the colors and use them to our advantage. The colors can be used in various chronotypes of therapy and treatment and can serve as a supplement to the main diagnostic and therapeutic methods.

An important part of the interpretation of the results is also the necessary caution in their generalization. It is impossible to draw definitive conclusions based on one experiment. In addition, as with the vast majority of other experiments, there is doubt as to the certainty of the representativeness of the data obtained with respect to the research sample and many other variables that may have influenced the research.

6- Declarations

6-1- Author Contributions

Conceptualization, V.G. and Y.Y.; methodology, V.G. and K.B.; writing—original draft preparation, V.G. and K.B.; writing—review and editing, V.G. and K.B. All authors have read and agreed to the published version of the manuscript.

6-2- Data Availability Statement

Data sharing is not applicable to this article.

6-3- Funding

This publication was issued as a result of IGA VŠDTI č. 004/2019 in the coordination with the DTI University Dubnica nad Váhom, Slovakia, Institute of Technology and Business in České Budějovice, Czech Republic and Simon Kuznets Kharkiv National University of Economics, Ukraine and as a result of EEIG project in the coordination with Institute of Technology and Business in České Budějovice, Catholic University in Ružomberok, Państwowa Wyższa Szkoła Techniczno-Ekonomiczna im. ks. Bronisława Markiewicza w Jarosławiu and West Ukrainian National University. At the same time, the presented publication is a partial output of research and research work of the VEGA project 1/0021/21 realized with coordination with Institute of Technology and Business in České Budějovice, Czech Republic.

6-4- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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