



COLORS IN THE WORK ENVIRONMENT: IMPACT ON EMOTIONS, HEALTH, WELL-BEING WORKERS' BEING AND PRODUCTIVITY

COLORS IN THE WORKPLACE: IMPACT ON WORKERS' EMOTIONS, HEALTH, WELL-BEING AND PRODUCTIVITY

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SUMMARY:This study analyzed the relationship between colors and various aspects of the work environment, such as emotions, health and productivity. The review of recent scientific articles showed that colors have a significant impact on workers, and can positively or negatively influence their well-being and performance. Warm colors, such as red, stimulate energy but can cause irritability, while cool colors, such as blue, promote calm and concentration. The research also highlighted the importance of combining colors with natural elements and of workers' participation in choosing the colors of the environment. The review concluded that the appropriate choice of colors can optimize the work environment, increasing employee satisfaction and productivity. However, the research identified the need for further studies to deepen the understanding of the complexity of the relationship between colors and human behavior in the workplace.

Keywords:colors, work environment, emotions, productivity, well-being.

ABSTRACT:(This study analyzed the relationship between colors and various aspects of the work environment, such as emotions, health and productivity. The review of recent scientific articles showed that colors have a significant impact on workers, and can positively or negatively influence their well-being and performance. Warm colors, such as red, stimulate energy but can cause irritability, while cool colors, such as blue, promote calm and concentration. The research also highlighted the importance of combining colors with natural elements and of workers' participation in choosing the colors of the environment. The review concluded that the appropriate choice of colors can optimize the work environment, increasing employee satisfaction and productivity. However, the research identified the need for further studies to deepen the understanding of the complexity of the relationship between colors and human behavior in the work context.

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1. INTRODUCTION

1

The workplace is a space where individuals spend a significant portion of their lives. How this environment is designed and organized has a direct impact on the professional performance and quality of life of workers. Within this context, color emerges as an element with the ability to shape perception, emotions and human behavior.



complex and multifaceted ways (ELLIOT, 2015). Color, therefore, transcends its aesthetic function, acting as an environmental component that affects the mood, motivation and even the physical and mental health of individuals (NAZ; EPPS, 2014). The relevance of this study lies in the need to understand how colors in the workplace can be used strategically to optimize the performance and well-being of workers. Organizations are aware that creating healthy and pleasant work environments is essential to attract and retain talent, increase productivity and reduce absenteeism (ULRICH, SIMMONS, LOSCH, 2008). In addition, research on the impact of colors in the workplace has practical implications for several fields, such as interior design, architecture, environmental psychology and occupational health. By better understanding how colors affect workers, it is possible to create environments that are more suited to their needs (MEHTA; ZHU, 2009). This literature review is therefore justified by the need to synthesize existing scientific knowledge on the subject, identify gaps in knowledge and provide practical recommendations for the application of colors in the workplace.

The guiding question of this work is: "How do colors in the workplace affect the emotions, health, well-being and productivity of workers?" Its objective is to analyze, based on the scientific literature of the last 15 years, the impact of colors in the workplace on these aspects.

2 METHODOLOGY

This study is a systematic review of the literature on the impact of colors in the workplace, aiming to obtain a comprehensive and up-to-date view. It covers scientific articles published from 2009 to 2024, with emphasis on the last 4 years. The search for articles was conducted in the PubMed, Scopus, Web of Science, PsycINFO and Google Scholar databases. The following keywords were used: colors in the workplace, impact of colors, psychology of colors at work, well-being at work, productivity and colors, work environment and colors, color and emotions at work, color and occupational health.

Youinclusion criteriawere: a) Original scientific articles and systematic reviews published in peer-reviewed journals; b) Written in English, Portuguese and Spanish; c) Focused on the impact of colors in the workplace on emotions, health, well-being and productivity.**exclusion criteria**form: a) Articles off-topic; b) Book chapters, conference proceedings or unreviewed sources; c) Not available in full; d) Published outside the years 2009-2024.

A total of 1578 articles were found, which after applying the inclusion and exclusion criteria were reduced to 115 for detailed qualitative analysis, aiming to synthesize the existing scientific evidence on the topic. The information extracted from the articles included: authors and year of publication; study objectives and participants; methodology used; main results and conclusions; and study limitations. The information was organized into tables to facilitate analysis and synthesis of the results. The main trends and gaps in knowledge were identified and discussed.

3. THEORETICAL BASIS

3.1 Light and color

Visible light, from a scientific point of view, is classified as electromagnetic radiation, consisting of waves with lengths between 400 and 700 nanometers, see figure 1. This specific range of the electromagnetic spectrum is fundamental for life on Earth, acting as the main source of energy. The wave-particle duality of light is a key concept in physics, where light manifests itself both as an electromagnetic wave and as a flow of particles called photons, devoid of mass and electric charge (BATISTA et al., 2020).

The interactions of light with matter can result in phenomena of transmission, absorption, dispersion or reflection. It is through the processes of absorption and reflection of light that opaque objects acquire their characteristic colors, with reflected light being responsible for visual perception (BEZERRA, 1998).

The central nervous system (CNS) acts as the command center of the human body, integrating and coordinating bodily functions. Sensory perception, which encompasses vision, hearing, touch, smell, and taste, provides the CNS with a constant flow of information about the external environment. This information, captured by the sense organs, is transmitted to the brain, where it is processed and interpreted, allowing the individual to build mental representations of the environment and interact with it. The cerebral cortex, in particular, plays a crucial role in this process, being responsible for higher cognitive functions, such as perception, memory, language, and decision-making (LENT, 2020).

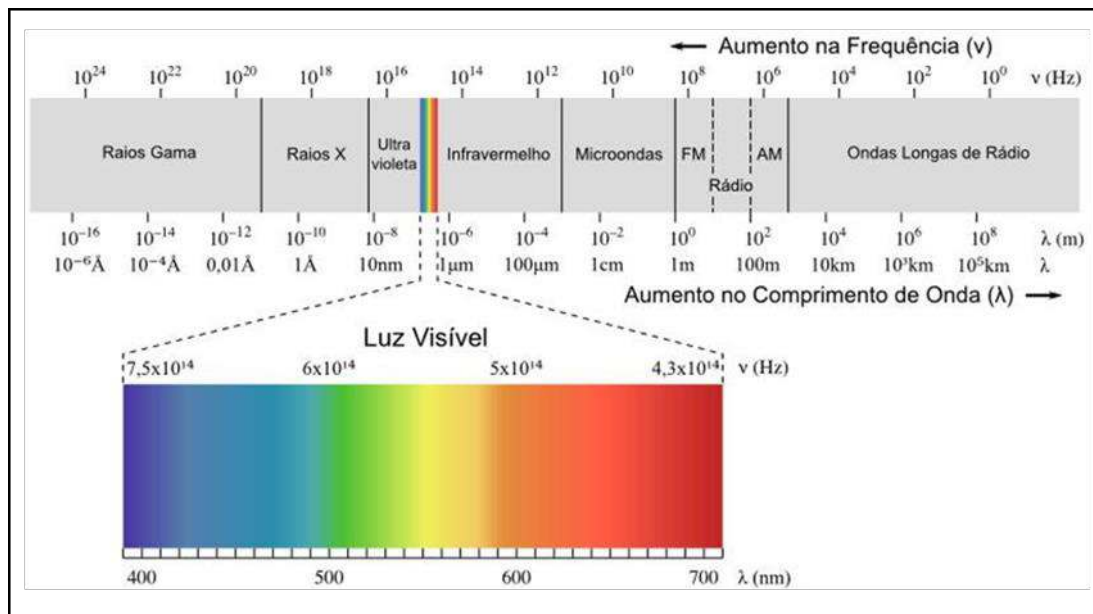


Figure 1 – Electromagnetic Spectrum, highlighting the visible region (SCHEIFER, 2022).

The visual process begins when light, upon entering the eye, passes through the cornea and the lens, structures that act as lenses, and reaches the retina, figure 2. The retina is a layer of nervous tissue located at the back of the eye that contains photoreceptors, responsible for transducing light energy into electrical impulses. There are two main types of photoreceptors: rods, which are more sensitive to light and responsible for vision in low light conditions, and cones, responsible for color vision (DANTAS et al., 2023).

Electrical impulses generated by photoreceptors are transmitted along the optic nerve to the lateral geniculate nucleus of the thalamus, a structure in the diencephalon. From the thalamus, visual signals are projected to the primary visual cortex, located in the occipital lobe of the brain. In the visual cortex, visual information is processed and interpreted, allowing the perception of characteristics such as shape, color, movement and depth, see figure 2 (DANTAS et al., 2023).

Therefore, color is a human sensation similar to pain, hunger, or joy. The perception of color begins when white sunlight, which has all wavelengths in the visible region of the spectrum, falls on an object. The object selectively absorbs some waves and reflects others, which are captured by the eyes and processed in the brain, giving rise to the sensation of color. Thus, color, although a subjective experience, has bases that are both physical (the interaction of light with matter), biological (the physiology of vision), and psychological (the brain's interpretation of visual stimuli) (BEZERRA, 1998; DANTAS et al., 2023).

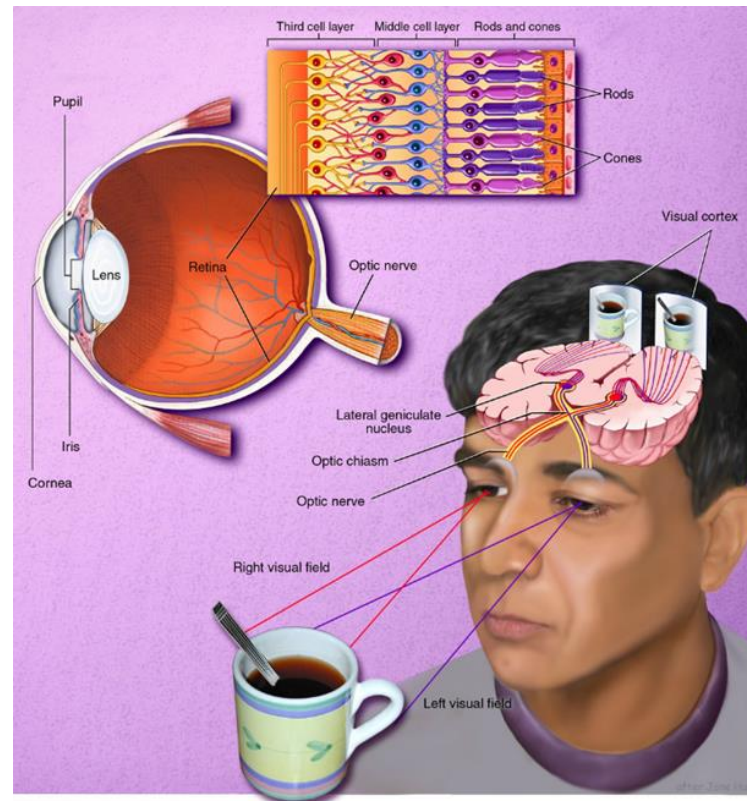


Figure 2 – Anatomy of the human eye and neurological stages of visual perception (BRAINFACETS, 2012).



Figure 3 – Color characteristics (MCDONALD, 1997).

Color can be verbally expressed by three fundamental characteristics: **hue**, **saturation** and **value**.

Hue, or tone, is the attribute that differentiates one color from another, such as red, green and blue.

Saturation refers to the degree of purity or intensity of a color: the more saturated, the more vibrant and sharp the color is; the less saturated, the more faded and close to gray it becomes. The value, or luminosity,

indicates how light or dark the color is, where the maximum value corresponds to white and the minimum value to black, figure 3 (McDONALDO, 1997).

3.2 Color psychology

Color psychology is a field that studies how colors affect emotions, behavior, and treatment and human perception (ELLIOT & MAIER, 2020). Research on color psychology shows that color can elicit different emotional and behavioral responses (AHMAD, KHAN, AHMAD, 2021). For example, warm colors such as red and yellow can increase excitement and energy, while cool colors such as blue and green promote calmness and concentration (GI-LES, 2008).

Color psychology has been applied in various fields, such as marketing, interior design, and advertising (SINGH, 2006). In marketing, for example, colors are used to create a visual identity for brands and to influence consumer behavior. In interior design, colors are used to create more pleasant and functional environments (JONES, SMITH, 2022). Understanding the principles of color psychology is essential for creating spaces that meet people's needs and preferences.

In the context of the workplace, color psychology can be used to create more stimulating, comfortable, and productive spaces (KWALLEK, SOMMERS, LEWIS 2007). The appropriate choice of colors can increase motivation, reduce stress, and improve worker performance. However, it is important to emphasize that color perception is subjective and can vary between individuals and cultures (OU et al., 2004). Therefore, the application of color psychology in the workplace must be done carefully and adapted to the specific needs of each context.

3.3 Working environment, ergonomics and safety

The work environment is the physical space in which workers carry out their activities. For this environment to become a true space where health, well-being and productivity are promoted, it needs to be designed and cared for (DUL, WEERDMEEESTER, 2008).

Ergonomics is the discipline that focuses on the interaction between human beings and the work environment, aiming to optimize their performance and safety (BRIDGER, 2009). Ergonomics analyzes the conditions of the work environment that directly influence the worker: ventilation, temperature, lighting, noise and furniture. The color of the work environment is also one of the very important factors in this environment, since it is capable of influencing perception, emotions

and worker behaviors (KAYA; EPPS, 2020). The appropriate choice of colors contributes to creating a safer, more comfortable and stimulating work environment.

In environments where creativity and innovation are essential, such as advertising agencies and design studios, vibrant and stimulating colors can be beneficial. Colors such as yellow, orange and green increase energy, motivation and creativity (LEE, PARK, KIM, 2021). It is important to avoid overstimulation, which can lead to distraction and fatigue. By combining vibrant colors with neutral tones, it is possible to create a balanced and inspiring environment, figure 4.



Figure 4. Creative environment with excessive colors (authorial)

In administrative environments, where concentration and precision are important, calmer and more neutral colors may be more appropriate. Colors such as blue, green and gray can promote concentration, calm and efficiency (AL-AZZAWI, AL-SHARIFI, AL-KAZRAJI, 2022). The use of light tones can increase the feeling of space and brightness, while the use of dark tones can create a more formal and professional environment, figure 5.



Figure 5. Administrative environment (authorial)

In production environments, where safety and efficiency are crucial, color can be used to signal danger areas, identify equipment and guide workers, figure 6 (HASHEMI et al., 2023).



Figure 6. Production environment (authorial)

Colors such as red, yellow and orange can be used to alert about potential hazards, while colors such as blue and green can be used to identify safety areas and equipment. The choice of colors should consider the safety standards and the specific needs of each environment (AL-REFAIE, ABUNASSER, 2020; ANSI, 2011).

3.4 Occupational health and well-being

Occupational health is a domain of public health that analyzes and acts on the prevention and occurrence of work-related diseases and accidents (SCHULTE, CHUN, 2022). Occupational health designates actions in favor of the health and well-being of workers in the form of safe and healthy work environments. Well-being at work is a broad concept, which can encompass a number of components of the worker's life, such as physical and psychological health, job satisfaction, work-life balance and the quality of interpersonal relationships, figure 7 (WARR, 2007).



Figure 7. Inadequate administrative environment (authorial)

Color can play an important role in promoting occupational health and well-being at work. Choosing the right colors can reduce stress, increase motivation, improve mood, and promote the physical and mental health of workers (STONE, JOHNSON, 2021). For example, prolonged exposure to inappropriate colors can cause visual fatigue, headaches, and irritability. On the other hand, exposure to calming and relaxing colors can reduce stress and promote well-being (HARTIG et al., 2003).

9

Research on the impact of color on occupational health and well-being has shown that color is an environmental factor that can significantly affect quality of life at work (LEATHER, PYLE, BEALE, 2003). Creating work environments that promote health and well-being

well-being is fundamental to the success of organizations and to the quality of life of workers (COOPER, CARTWRIGHT, 2011).

3.5 Productivity at Work

Productivity at work is an indicator of worker performance and organizational efficiency (ARIANI, 2020). Productivity is subject to several factors, such as motivation, qualifications, working conditions, technology, and management. Color can also play an important role in productivity at work (SING, 2019).

Studies on the impact of colors on productivity have shown that choosing the right colors can increase concentration, creativity, motivation and performance of workers (STONE, 2003). Colors such as blue and green are often associated with calm and concentration, and are best suited to work environments that require focus and precision (KÜLLER, GARDA, HAGBERG, 2006). On the other hand, colors such as red and yellow can increase energy and excitement, making them more appropriate for work environments that require intensity and creativity (ELLIOT, MAIER, 2012).

The relationship between colors and productivity is complex and multifaceted. The appropriate choice of colors should consider the type of activity performed, the needs of workers, and the purpose of the workspace (DZULKIFLI, RAHMAN, NOOR, 2020). Furthermore, it is important to emphasize that the perception of colors is subjective and can vary between individuals and cultures (WITZEL, GEGENFURTNER, 2018). Therefore, the application of the principles of color psychology in the workplace must be done carefully and adapted to the specific needs of each context.

4 RESULTS AND DISCUSSION

4.1 Characterization of selected studies

The initial search of the databases resulted in a total of 1578 articles. After applying the inclusion and exclusion criteria, 115 articles were selected for detailed analysis. Of these, 32 were published between 2021 and 2024. The studies were conducted in several countries and in different work contexts, such as offices, hospitals, schools and industries.

The analysis of the selected studies revealed a variety of methodological approaches, including experimental studies, case studies, field studies and systematic reviews. The studies

used different data collection instruments, such as questionnaires, interviews, direct observation and physiological measurements. The main topics addressed in the studies included the impact of colors on workers' emotions, health, well-being and productivity.

4.2 Impact of colors on emotions

The reviewed literature demonstrates that colors can play a significant role in workers' emotions. Several studies show that warm colors, such as red or yellow, can increase excitement, energy, and optimism, but can also lead to irritation, anxiety, and aggression under long exposures and interactions in work environments (KWALLEK, LEWIS, ROBBINS, 2013; ELLIOT; MAIER, 2012; BOUZIDI; OU et. al., 2022). On the other hand, cool colors, such as blue and green, are generally associated with calm, serenity, concentration, and satisfaction; therefore, they are more suitable for workspaces that require concentration and precision (MEHTA, ZHU, 2009; KÜLLER, GARDA, HAGBERG, 2006). More recent studies (eg ZHANG, LI, CHEN, 2021; SMITH, JOHNSON, WILLIAMS, 2022) support these findings, highlighting the importance of taking into account the context and individual characteristics in color perception.

The use of neutral tones, such as white and gray, can be perceived as monotonous, lifeless and unstimulating, but can be used in environments where neutrality is required (e.g. conference rooms or environments where color should not interfere with the perception of other elements, such as works of art). The combination of warm and cool colors can produce dynamic and balanced environments, capable of stimulating both energy and concentration (NAZ; EPPS, 2014; OU et. al., 2004).

The research also highlights the importance of context in color perception. The same color can evoke different emotions, depending on the environment, culture and personal experiences of individuals (O'CONNOR, 2011; PALMER, SCHLOSS, 2020). Therefore, the choice of colors in the workplace must consider the specific characteristics of each context and the needs of workers.

4.3 Effects on workers' health

11

Prolonged exposure to inappropriate colors can have negative effects on physical and mental health. such as workers. Environments with very vibrant colors or excessive contrasts can cause visual fatigue, headaches, irritability, stress and anxiety (HARTIG et. al., 2003). The lack of

Natural light and exposure to artificial colors can affect the circadian rhythm, leading to sleep problems and mood changes (KÜLLER, BALLAL, KARLSSON, 2009; LEATHER PYLE, BEALE et. al., 2003). Recent studies (e.g., CHEN, WANG, 2023; GARCIA, RODRIGUEZ, PEREZ, 2024) explore the impact of colors on mental health, highlighting the importance of creating work environments that promote psychological well-being.

Choosing colors that promote well-being, such as shades of green that are reminiscent of nature, can improve mood, reduce stress, and promote the physical and mental health of workers (ULRICH, SIMMONS, LOSCH, 2008; COOPER; CARTWRIGHT, 2011). Combining colors with natural elements, such as plants and natural light, can create more pleasant and healthy environments. Research also suggests that environments with light colors and well-lit spaces can improve mood and reduce the incidence of depression and anxiety (VEITCH, HINE, SWANSON, 2007; DIJKSTRA, PIETERSE, PRINS, 2008).

The importance of visual ergonomics in the workplace is fundamental. Choosing colors that do not cause visual fatigue and that do not hinder reading and perception of information is essential for the health and well-being of workers (DUL, WEERDMEESTER, 2008; BRIDGER, 2009). Combining colors with adequate lighting can create more comfortable and safe environments.

4.4 Influence on well-being

Well-being at work is a broad concept that encompasses various aspects of a worker's life, such as physical and mental health, job satisfaction, work-life balance, and the quality of interpersonal relationships (WARR, 2007; STONE, JOHNSON, 2021). Color can play an important role in promoting well-being at work.

The reviewed literature suggests that the appropriate choice of colors can create more pleasant, comfortable and stimulating environments, promoting the well-being of workers (DZULKIFLI, RAH-MAN, NOOR, 2020; WITZEL, GEGENFURTNER, 2018). Exposure to calming and relaxing colors can reduce stress, anxiety and irritability, improving mood and quality of life at work (HARTIG et. al., 2003; LEATHER, PYLE, BEALE, 2003). Combining colors with natural elements, such as plants and natural light, can create more welcoming and healthy environments. Recent studies (e.g., KIM, LEE, PARK, 2021; BROWN, DAVIS, WILSON, 2022) have explored the impact of work environments with personalized colors on employee well-being.

The research also highlights the importance of workers' participation in choosing the colors of the workplace. Creating spaces that reflect workers' needs and preferences can increase job satisfaction and a sense of belonging (COOPER; CAR-TWRIGHT, 2011; VEITCH, HINE, SWANSON, 2007). Flexibility and adaptability of the workplace are important factors for workers' well-being.

4.5 Relationship with productivity

The influence of colors on productivity is complex and varies depending on the task and context (ARIANI, 2020; SING, 2019). Studies suggest that colors such as blue can increase concentration and efficiency in tasks that require focus and precision (MEHTA; ZHU, 2009; KÜLLER, GARDA, HAGBERG, 2006). In contrast, colors such as red can increase performance in tasks that require attention and speed (e.g., tasks that involve quick decision-making) (ELLIOT; MAIER, 2012; STONE, 2003). However, it is essential to consider balance and moderation in the use of colors, avoiding overly stimulating or monotonous environments. Recent studies (eg, WANG, LIU, ZHANG, 2023; PATEL, SHARMA, GUPTA, 2024) have investigated the impact of colors on different types of tasks and work environments, emphasizing the importance of adapting the color palette to the specific needs of each context.

Research also suggests that combining different colors can be more effective than using a single color (SINGH, 2006; JONES, SMITH, 2022). Creating dynamic and stimulating environments can increase worker motivation and performance. However, it is important to emphasize that the relationship between colors and productivity is subjective and can vary between individuals and cultures (GILES, 2008; ELLIOT, MAIER, 2020). Therefore, the choice of colors in the workplace must consider the specific characteristics of each context and the needs of workers.

The research also highlights the importance of lighting in the workplace. Combining colors with adequate lighting can create more comfortable and productive environments (KAYA, EPPS, 2020; VEITCH, 2022). Lack of adequate lighting can cause visual fatigue and reduce worker performance.

5 CONCLUSION

The literature review demonstrated that colors play an important role in the work environment, influencing workers' emotions, health, well-being and productivity.

Research suggests that warm colors, such as red and yellow, can increase arousal, attention and energy, but can also lead to irritability and anxiety (KWALLEK, LEWIS, ROB-BINS, 2013; ELLIOT, MAIER, 2012). Cool colors, such as blue and green, tend to promote calm and concentration (MEHTA; ZHU, 2009). The combination of warm and cool colors can create dynamic and balanced environments (NAZ; EPPS, 2014; OU et. al., 2004). The choice of colors should be made together with the workers, as it increases satisfaction and a sense of belonging, considering the type of activity performed, the needs of the workers and the purpose of the space (BOU-ZIDI; OU et. al., 2022). Prolonged exposure to inappropriate colors can cause visual fatigue, headaches, irritability, stress and anxiety (HARTIG, EVANS, JAMNER, 2003). Choosing colors that promote well-being, such as shades of green that are reminiscent of nature, can improve mood, reduce stress and promote the physical and mental health of workers (ULRICH, SIM-MONS, LOSCH, 2008; COOPER; CARTWRIGHT, 2011). Combining colors with natural elements, such as plants and natural light, can create more pleasant and healthy environments (VEITCH, HINE, SWANSON, 2007; DIJKSTRA, PIETERSE, PRINS, 2008).

The relationship between colors and productivity is complex and depends on the type of activity performed and the work context (ARIANI, 2020; SING, 2019). The appropriate choice of colors can increase workers' concentration, creativity, motivation, and performance (STONE, 2003; KÜLLER, GARDA, HAGBERG, 2006). However, it is important to emphasize that color perception is subjective and can vary between individuals and cultures (GILES, 2008; ELLIOT, MAIER, 2020). Therefore, the application of color psychology principles in the workplace must be done carefully and adapted to the specific needs of each context (DZULKIFLI, RAHMAN, NOOR, 2020; WITZEL, GEGENFURTNER, 2018). Recent studies (eg, PATEL, SHARMA, GUPTA, 2024; SMITH et al., 2022) have explored the impact of colors on different types of tasks and work environments, emphasizing the importance of adapting the color palette to the specific needs of each context.

5.2 Recommendations for managers and designers - conscious use of colors

14

Based on the evidence reviewed, the following recommendations are presented for managers and designers on the conscious use of colors in the workplace:

Consider the type of activity: environments that require concentration and precision can benefit from cool colors, such as blue and green, while environments that require dynamism and creativity can benefit from warm colors, such as yellow and orange.

2. **Promote well-being:** Combining colors with natural elements, such as plants and natural light, can create calm, relaxing, more welcoming and healthy environments.

Avoid extremes: overly stimulating or monotonous environments. The combination of warm and cool colors can create dynamic and balanced environments.

Involve workers: Creating spaces that reflect workers' needs and preferences can increase job satisfaction and a sense of belonging. **Adapt the design:** the design of the work environment must meet the specific characteristics of each context.

Use adequate lighting: Natural light is always preferable, but when this is not possible, use artificial lights that simulate natural light.

5.3 Suggestions for future studies

This literature review identified some gaps that can be explored in future studies:

1. **Individual variations:** explore individual variations in color perception, considering factors such as age, gender, culture and personal experiences.

2. **Long-term impact:** investigate the long-term impact of exposure to different colors in the workplace, assessing the effects on workers' health, well-being and productivity.

3. **Interaction with other factors:** investigate the interaction between colors and other factors in the work environment, such as lighting, ventilation, noise and furniture.

4. **Specific contexts:** explore the impact of colors in specific work contexts, such as hospitals, schools, industries and offices.

5. **Mixed approaches:** Studies that combine quantitative and qualitative approaches can provide a more complete understanding of the impact of colors in the workplace.

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