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# The psychological dimension of colors: a systematic literature review on color psychology[1]

**A dimensão psicológica das cores: uma revisão sistemática da literatura sobre a psicologia das cores**

**La dimensión psicológica de los colores: una revisión sistemática de la literatura sobre la psicología del color**

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**Abstract**
This paper seeks to contribute to the discussions concerning the study area of colors. Bearing in mind that the psychological effects of colors on individuals' cognition are gaining more and more space, whether in psychology itself or the areas of marketing and product development. Therefore, we sought to identify how color psychology has been debated in the scientific community. In this way, the present article aims to understand how studies on the psychological dimension of colors in scientific works have gone from their first publication to the present, more specific 2020. A systematic bibliographic review was carried out that mapped scientific papers, dissertations, and theses, resulting in 116 texts. The methodology used is descriptive, quantitative, and qualitative in its approach. As a result, the research determined 2006 as a marker for developing and disseminating publications in scientific paper format in the area. Also, we found a predominance of experimental theory research, with primarily qualitative approaches and exploratory objectives. We found that the focus of the authors is to research universities. We found the leading countries with research in color psychology, such as the United States and Brazil.
**Keywords:** Colorimetry; RBS; Psychological perception; Color psychology; Color studies.

**Resumo**
Este artigo busca contribuir nas discussões referentes à área de estudo das cores. Tendo em mente que os efeitos psicológicos das cores na cognição dos indivíduos vêm ganhando cada dia mais espaço, seja na própria psicologia, como nas áreas de marketing e desenvolvimento de produto, buscou-se identificar como este conteúdo vem sendo debatido na comunidade científica. Dessa forma, o presente artigo tem como objetivo compreender como transcorreram os estudos acerca da dimensão psicológica das cores em trabalhos científicos desde a sua primeira publicação até o ano de 2020. Para isso, foi realizado uma revisão bibliográfica sistemática que mapeou artigos, dissertações e teses, obtendo como resultado 116 textos. A metodologia trabalhada é classificada, quanto aos seus objetivos, como descritiva, e quanto à sua abordagem como quantitativa e qualitativa. Como resultado, a pesquisa

[1] Expanded from the conference paper *"A systematic bibliographic review into color psychology: the main researched items"*, published in 2020 during the XVI Color Conference at Bergamo (Italy).

determinou o ano de 2006 como marcante para o desenvolvimento e difusão das publicações em formato de artigo na área. Ainda, encontrou a predominância de pesquisas de teor experimental; com maioria de abordagens qualitativas; e de objetivos exploratórios. O foco dos autores sendo totalmente voltados às universidades. Encontrou-se ainda os principais países com pesquisas em psicologia das cores como sendo Estados Unidos e Brasil.
**Palavras-chave:** Colorimetria; RBS; Percepção psicológica; Psicologia das cores; Estudos das cores.

**Resumen**
Este artículo busca contribuir a las discusiones sobre el área de estudio de los colores. Teniendo en cuenta que los efectos psicológicos de los colores en la cognición de los individuos están ganando cada vez más espacio, ya sea en la propia psicología, como en las áreas de marketing y desarrollo de productos, buscamos identificar cómo este contenido ha sido debatido en la comunidad científica. De esta forma, el presente artículo tiene como objetivo comprender cómo han avanzado los estudios sobre la dimensión psicológica de los colores en los trabajos científicos desde su primera publicación hasta el año 2020. Para ello, se realizó una revisión bibliográfica sistemática que mapeó artículos, disertaciones y tesis. resultando en 116 textos. La metodología utilizada se clasifica, en cuanto a sus objetivos, en descriptiva, y en cuanto a su enfoque, en cuantitativa y cualitativa. Como resultado, la investigación determinó el año 2006 como un hito para el desarrollo y difusión de publicaciones en formato artículo en el área. Aun así, encontró el predominio de la investigación experimental; con la mayoría de los enfoques cualitativos; y objetivos exploratorios. El enfoque de los autores está totalmente orientado a las universidades. También se encontraron los principales países con investigaciones en psicología del color, como Estados Unidos y Brasil.
**Palabras clave:** Colorimetría; RBS; Percepción psicológica; Psicología del color; Estudios de color.

## 1. Introduction

Colors are present in society's daily life and are systematically planned by designers when the objective is to attract attention (Holtzschue, 2011). Their language is broad and usually acts in the subconscious, making connections with other moments or objects whose memory has already been stored in the brain (Guimarães, 2000). Even if unconsciously, the mind will react positively or negatively when faced with a specific color combination. To this end, color can be defined as a perceived and sensory sensation resulting from the action of light on the eyes (Silveira, 2015; Ribeiro, 2011). Colors are of fundamental importance in the lives of human beings since they are capable of provoking different stimuli. Farina et al. (2006) say they have specific vibrations in our senses, producing sensations and sensory reflexes of great importance and operating as a stimulant in our emotions.

Color preferences are often determined through lived experiences; at times, one prefers one color over another because it causes memories of a past moment. Farina et al. (2006) state that colors constitute stimuli that influence individuals to like or not something.

Ferreira Júnior (2015) divides color into four dimensions of observation, comprising the areas: physiological, psychological, physical, and chemical. Each area is responsible for bringing out specific developments in color, from pigment research to sociocultural semantics. Thus, from a physical point of view, studies on the chromatic effects of light reflection and refraction on the retinas are attributed to color; therefore, the importance of understanding color related to physics is centered on the path that the light ray makes between the object and human vision, in addition to understanding the variation of hues, tones, and values (Toma et al., 2005; Silveira, 2015). On a chemical level, the goal is to study color as an objective matter, that is, products such as enamel, paints, and everything related to the production of pigments (Ferreira Júnior, 2015).

In color physiology, Azevedo et al. (2000) and Pedrosa (2008) explain that color is studied in terms of perception by the brain, while Silveira (2015, p. 79) lists the importance of this study by stating that "certain choices of color combinations can be attributed to physiological comfort or discomfort. In addition to physiology, psychology studies the theme, focusing on the meanings attributed to colors in social, cultural, and historical environments. The symbology of colors is a process of understanding the meaning inherent to objects across cultures and times and the projection of sensations and emotions in the human mind from the effects of these chromatic elements (Heller, 2013; Pedrosa, 2014).

Bearing this in mind, color psychology studies the influence that some colors have on the human mind (Ferreira Júnior, 2015) and identifies the sensations of the environment and how they influence the perception of what is around us. For

product development, this perception should be used as input and innovation objectives because the change in the color of an artifact can often provoke a new stimulus in the consumer.

In order to know more about the psychological dimension of colors, it was necessary to carry out a bibliographic study on the works that have been published in recent years, and for more consistent research, the method of systematic analysis was used, where the survey is carried out. Much of the literature related to the subject, thus generating results with new concepts addressed on the same topic (Webster; Watson, 2002). In order to analyze the existing bibliography, we sought to work the research from the following research question:

> ***Research Question****: How has the area of color psychology been studied in scientific productions since its first mapped publication until 2020?*

In order to answer the question, the methodological processes were adapted from the research applied by Solino et al. (2015). Based on this, a systematic literature review was carried out to achieve the following purposes: identify and classify publications by year, country, university, area, host country, type of study, method, type of approach, objective, country studied (Solino et al., 2015). To achieve the results, this paper was outlined as follows: in addition to this first preface, a second part is exposed that portrays the step by step of systematization methodology applied in the research. The third focuses on analyzing the current state of the art in color psychology. The fifth part presents the final considerations and suggestions for future research.

## 2. Methodology

The application of a solid methodology becomes fundamental to validate any scientific research, and the applied methodology manages to trace paths to achieve the objectives and results that the researcher aims. The present research is classified, in terms of its type of study, as a systematic literature review, defined through the words of Mattos (2015) and developed by Santos et al. (2018) as a scientific investigation of greater magnitude, having as its primary objective to survey, gather and critically evaluate the methodological process used in the research, synthesizing its results. This type of study has several advantages since systematic reviews incorporate a broader range of significant results for research instead of reaching certain conclusions based only on reading a few articles (Sampaio& Mancini, 2006).

This article is classified as descriptive research, in which, according to Gil (2008), its main focus is the description of the particularities and variables present in a specific society or phenomena. Thus, exposing how the psychological dimension of colors has been working in scientific research within a time frame. Its approach is quantitative and qualitative research due to the virtual survey of scientific papers followed by an analysis of these studies. Fonseca (2002) expresses that, in the quantitative approach, data are collected and quantified, focusing on the objectivity of the studies and using mathematical language to describe the leading causes of a phenomenon. In addition, both the author mentioned above (2002) and Gil (2008) define the qualitative approach as being focused on aspects that are not quantified, as it focuses on understanding and explaining the dynamic form and information collected from the relationships between variables. To develop the systematic literature review, the script used in the research carried out by Solino et al. (2015) was adapted according to Santos et al. (2018) recommendations.

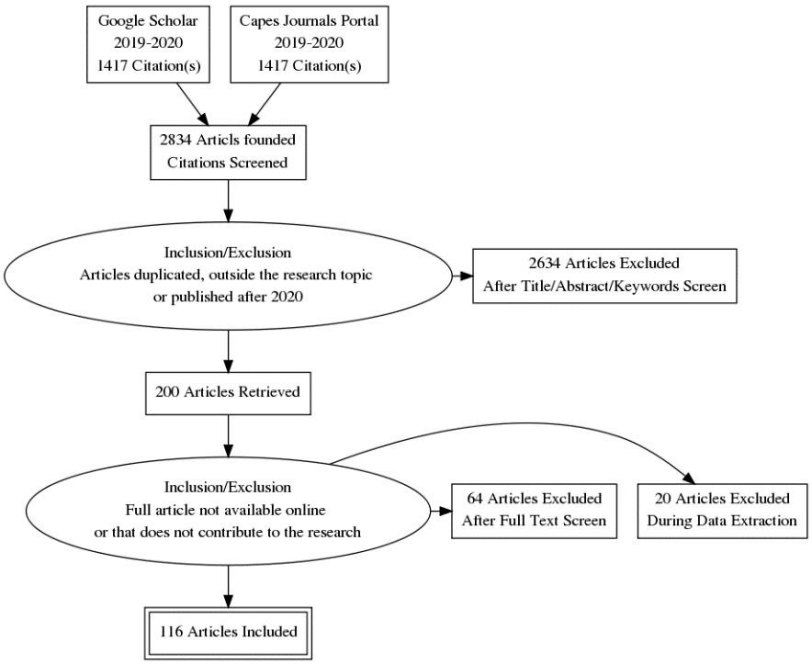
The study process was carried out in six stages. The first was to select which computerized databases would be the object of study; the second was the choice of keywords. In the third, the effective search of the studies was conducted, followed by a review of titles, abstracts, and keywords. The fifth, in turn, dealt with the exclusion of studies that did not meet the proposed specificities, and finally, there was a parallel reading to the exclusion of full texts that were not related to the researched topic.

**2.1 Technical Procedures**

As mentioned above, the present study was developed within six stages, where, first, (i) two computerized databases were chosen focused on the indexing of scientific works: a) Google Scholar, as previous studies suggested the validity of its application when whether research is being carried out in the areas of social sciences, arts, and humanities (Kousha et al., 2011); and, b) Portal de Periódicos da Capes, a Brazilian digital library that provides open access to all articles in the world to Brazilian universities (Almeida et al., 2010), "Currently it offers more than 120 databases of bibliographic references and abstracts and the full text of about 12,400 national and international journals in all areas of knowledge" (Cendon & Ribeiro, 2008, p. 157). Through investigation in these two databases, it is possible to obtain an expressive amount of works to be analyzed.

Soon after, (ii) four keywords were defined, in Portuguese and English, in order to obtain a more extensive filtering and a more accurate review of the texts related to the theme, these were: "Psicologia das Cores" and "Color Psychology". Together with this, to capture theses and dissertations, the keywords "Psicologia das cores dissertações" and "Color Psychology Thesis" (Figure 1) were also used.

**Figure 1 –** Search selection strategy flowchart.




Source: Authors.

Extensive research was conducted in both databases, opening the search to select scientific papers, PhD dissertations, and master theses. As an exclusion criterion, it was decided to eliminate only studies carried out in 2021 and 2022, as the research cycle had not yet been completed by the time of the development of this literature review. Thus, only works published up to the year 2020 were considered.

Also, for the most accurate development of the review, (iii) it was determined that up to 40 pages from each of the databases would be searched, namely the Capes Journal Portal and Google Scholar, since from that number of pages, the works that appear tend either to be repeated or to have no more relation to the topic discussed. As for the keywords applied in the Portal of Periodicals of Capes, we searched: "Psychology of Colors" in 40 pages, resulting in 8 works, all articles; "Color Psychology" in 40 pages, 41 texts were obtained, being one dissertation and 40 articles, and with the words "Color Psychology Thesis" in 40 pages, resulted in five works, one dissertation and four articles. In Google Scholar, it was determined that up to

40 pages would be searched with the keywords: "Color Psychology", obtaining 27 works, being 19 articles and eight dissertations/thesis, and up to 40 pages searched with the keywords' Color Psychology ', obtaining 35 texts, all articles.

Soon after, in the fourth step, (iv) the analysis of titles, abstracts, and keywords was performed to identify which results were related to the terms used. In the fifth stage, (v) texts that did not have the complete material available and also, as mentioned, did not have a direct or indirect relationship with the theme of color psychology were excluded. After carrying out the steps mentioned above, a final total of 116 works was obtained. One hundred six were characterized as scientific articles, and 10 were the results of theses and dissertations. After this totality, we tried to understand how color psychology has been approached in scientific research through some pre-defined topics to develop the Systematic Literature Review.

Bento (2012) identifies the relevance of carrying out literature reviews by bringing up the idea of understanding the current state of research around a given topic. Thus, it is necessary to understand the principal methodologies and views explored and worked on in these publications. Thus, in the sixth stage (vi) to collect information, the topics were divided into type of study, year of publication, color concept, type of approach, objectives, object, author's focus, country of research, and country researched by the scientific papers' authors.

After choosing points that were considered necessary for constructing the interpretation worksheet, the 116 texts were read, followed by an analysis of the documents and completion of the entire table.

## 3. Results and Discussion

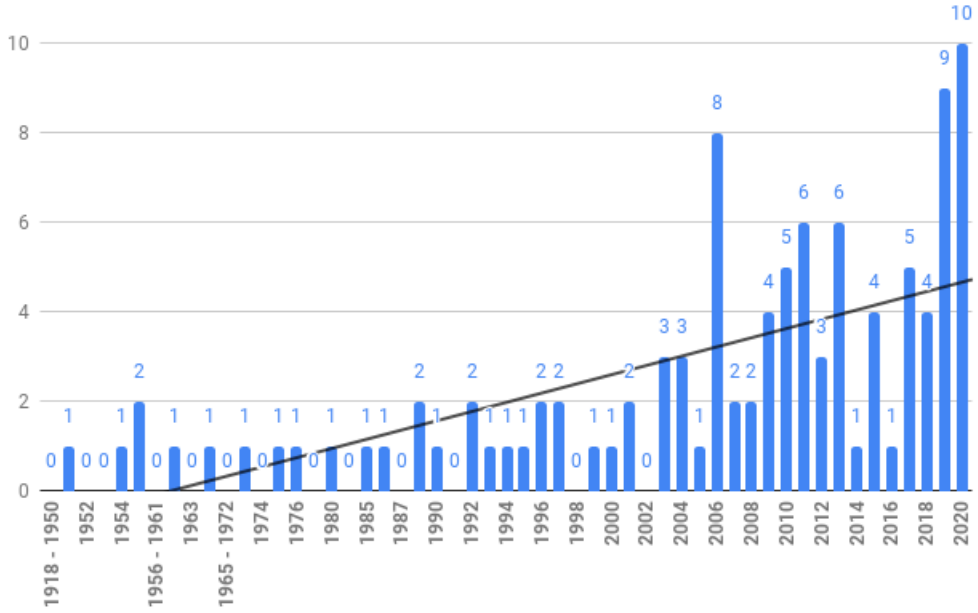
In this topic, information about all the systematized and read productions on the psychology of colors found, published until 2020, will be discussed, ranging from articles to master's thesis and doctoral dissertations. Contents such as chronological development, research sources, methodological characterization of the research, limitations, and suggestions for future research will be addressed.

### 3.1 Chronological development of studies

The first study in the scientific paper format found virtually on the psychological dimension of colors took place in 1917, while the first mapped master's research was produced in 1967, and the first doctoral dissertation found was published in 2011.

The development of research in the area in a chronological sense dragged on slowly (Figure 2), so that, within the first decade of the 20th century, until the mid-1980s, the annual averages of publications were in a low quantitative, being below, inclusive of 0.5 article published per year. From the next decade, that is, the 1980s, studies began to have a relevant appearance, with about 1.2 articles per year, increasing by about 1 article per interval in contrast to previous decades. The following decade, 1998 to 2007, following a growth line, presented an average of 2.1 articles per year, demonstrating a disruptive growth, practically doubling its number of publications, mainly between 2003 and 2007.

**Figure 2** – Number of papers distributed over time.




Source: Authors.

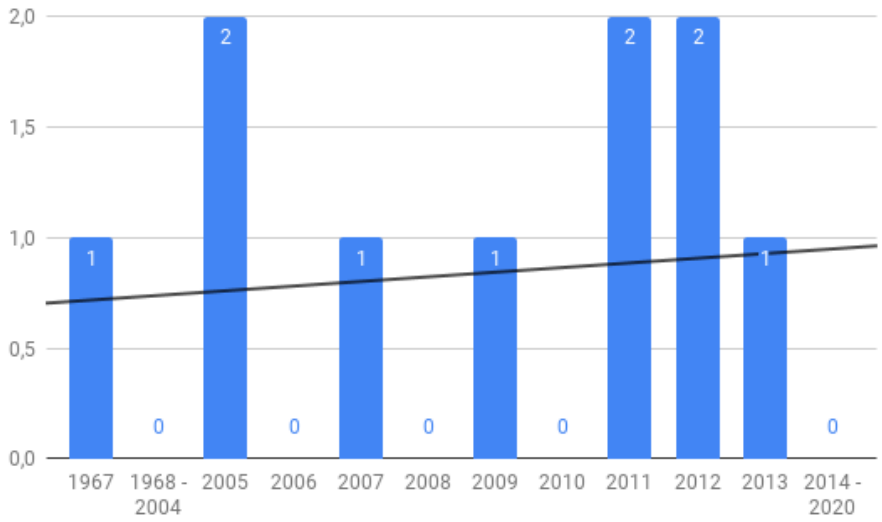
Publications in the field of color psychology have consolidated in the last 13 years, 2008 to 2020, with an approximate average of 5 articles per year. With this information, it can be seen that publications in article format reached their peak in 2006, with eight publications, and this ended up becoming a pivot for the development of the area, because, after this period, the theme started to have a more expressive volume of texts. Among the 102 years that made up the mapping timeline of works in the present systematic literature review, 61 years presented 0 research, with this concentration being more focused on the first decades of the 20th century, with the majority until at least the seventh decade mapped (1977). -1986); however, it was only in the last 12 years (2008-2020) that every year had an incidence of at least one publication, which shows an increasing degree of importance for this sphere of research.

Among these studies, 89.62% (95 articles) were developed about debates in color-light or color-pigment; they study color in its light emission state or material state, reflected by objects. On the other hand, 10.38% of the surveys (11 articles) discussed color as an ethnic sign, that is, the color of human skin, with consequences for the sociocultural dynamics of society.

In terms of dissertation and thesis format, both maintained similar patterns, with the highest numbers being 2005, 2011, and 2012, with two research, developed each year (Figure 3). The number of master thesis found was significantly higher than the number of PhD dissertations, 9 and 1.

Although 2006 was the highest number of papers in article format, no research developed in dissertation or thesis format was found. The texts in this format ended up having an even longer development, with many years without publications, the first was in 1967, and only after 38 years, there were occurrences of new publications in the area, that is, in 2005. These few incidences lasted until the end of 2020, with fluctuations between the years, the last year with the publication of a dissertation or thesis found through the research was the year 2013, and the following five years did not present new works.

**Figure 3** – Number of Master and PhD research distributed over time.




Source: Authors.

Among these researches, 90% (that is, nine works) deal with studies in color-light and color-pigment, coming from postgraduate studies in health, architecture and urbanism, arts, and marketing. Only one of the researchers discusses skin color being within the focus of the area of social psychology.

### 3.2 Academic research and its sources

Of the 106 articles mapped during the research, 25% come from Brazilian publication platforms. In contrast, 75% are productions resulting from international platforms, categorized here both papers from scientific journals and articles from the proceedings of scientific conferences, which, in turn, have ISSN or ISBN. Initially debating journal articles, in general, as shown in Table 1, it is clear that there is no exponential pattern of journals in which a majority of publications are presented. However, “Color Research & Application”, an American journal dedicated solely to color research, alone leads the publication of articles in the area.

**Table 1** – Number of studies in scientific journals.

| Scientific Journals | Amount | Percentage |
|---|---|---|
| Color Research & Application | 9 | 8,82% |
| Psicologia USP | 5 | 4,90% |
| The Journal of Psychology | 4 | 3,92% |
| Journal of Experimental Psychology: Human Perception and Performance | 3 | 2,94% |
| Psychology and marketing | 3 | 2,94% |
| InfoDesign | 3 | 2,94% |
| Journal of Experimental Psychology: General | 3 | 2,94% |
| Journal of Experimental Psychology | 2 | 1,96% |
| Journal of Black Psychology | 2 | 1,96% |
| Journal of Cross-Cultural Psychology | 2 | 1,96% |
| Journal of Experimental Psychology | 2 | 1,96% |
| The American Journal of Psychology | 2 | 1,96% |
| The Journal of General Psychology | 2 | 1,96% |
| The Journal of Social Psychology | 2 | 1,96% |
| Others | 58 | 56,86% |

Source: Authors.

Despite this notion, leadership, in a quantitative sense, as seen in Table 1, is related to the works categorized in 'Others', that is, 55 journals from the most diverse areas related to the theme that only presented an incidence of only one publication each, demonstrating a low degree of concentration of platforms that receive these researches.

In terms of quantity, the most noticeable pattern is the information that most articles are disseminated on platforms dedicated to the study of psychology (51.47%) compared to other areas. Only one of the journals found is aimed solely at publishing works that discuss colors (Color Research & Application). As a consequence of the scarcity of platforms that are entirely aimed at receiving works about colors, it is possible to perceive that the secondary thematic focus of the work, in addition to color, becomes the destination where the work will be disseminated. Thus, publications in. journals in psychology, marketing, design, and business. This factor explains, in turn, the vast number of works spread among the most various journals, without an overly perceptive consistency.

It is worth emphasizing the Journal of Experimental Psychology as relevant in this context, given its dominance of 7.84% of publications within the general data of the research corpus when adding up all its sub-areas of publication that appeared in this systematic review work. Debating only the journals that make up the group mentioned above of journals from the same institution, the Journal of Experimental Psychology: Human Perception and Performance and the Journal of Experimental Psychology: General are prominent, with 33.33% of the publications each in the area of color psychology only when referring to the magazine group, with this number corresponding to 2.94% each, in the general survey; then comes the Journal of Experimental Psychology with 22.22%, which is equivalent to 1.96% within the general data, lastly, with the Journal of Experimental Psychology: Learning, Memory and Cognition, with 11.11%, which corresponds to a total of 0.98% within the general search for journals.

As for full articles published in conference proceedings with ISSN or ISBN, only four appear from the Fashion Colloquium, one from the Brazilian Congress of Communication Sciences, one from the West Potiguar Computing Meeting, one from the Congress on Communication and Art.

When analyzing the works resulting from master's and doctoral research, ten texts were mapped, where 40% of these were developed by Brazilian universities, while another 40% come from Portuguese universities and the remaining 20%

represent Canadian and North American universities (Table 2). The absence of other countries is due to the usability of the applied search terms, predominantly in Portuguese and English, thus, such as “Color Psychology” or “Psicologia das Colors”. Those are not universal terms that characterize the entire research area, if necessary, to capture a broader range of works in other languages, the translation of keywords for searches and direct analysis within the dominant language of each social medium.

**Table 2** – Number of studies carried out by each university.

| Universities | Amount | Percentage |
|---|---|---|
| Universidade Federal de Goiás | 1 | 10,00% |
| Universidade Federal de Santa Catarina | 1 | 10,00% |
| Universidade de São Paulo | 1 | 10,00% |
| Instituto Superior de Psicologia Aplicada | 1 | 10,00% |
| Universidade Federal de Sergipe | 1 | 10,00% |
| University of California | 1 | 10,00% |
| University of British Columbia | 1 | 10,00% |
| Universidade do Minho | 1 | 10,00% |
| Universidade Técnica de Lisboa | 1 | 10,00% |
| Universidade da Beira Interior | 1 | 10,00% |

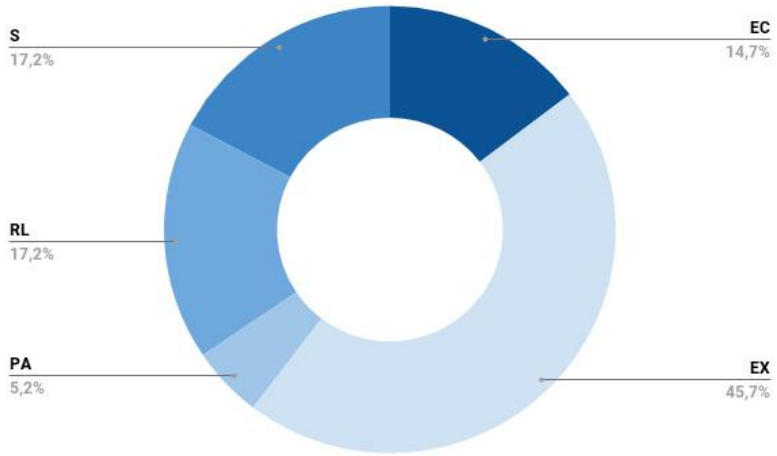
Source: Authors.

As for the postgraduate courses related to these universities, ten courses were extracted scattered in educational institutions around the world, with this not presenting a standard, being these courses with different nomenclatures, but sharing related areas of knowledge. Six of the ten courses are related to postgraduate studies in Psychology and its derivations, two are related to Architecture, one is related to the area of Arts, and the last course is related to research in Fashion and Marketing.

### 3.3 Methodological characterization of the research, author’s residence and headquarters of the study object

Starting with the type of study, its classification was made considering the primary type used (Figure 4); with this, the experimental research was present in a more significant number of works (45.7%). The literature review appeared in 17.2% of the publications and the survey (17.2%), followed by the case study, with 14.7%. Analytical research appeared in 6 studies (5.2%), thus being the least applied research method (Figure 4).

**Figure 4** – Number of works performed by type of study [2]




Source: Authors.

As for the approach, the quantitative-qualitative research appeared in most of the works, with 67.75%, followed by the qualitative, with 35.34% of presence, finally being the purely quantitative research (6.90%). Thus, it was observed that the only quantitative research showed little prominence as a consequence of the psychological analysis of colors presenting a broad aspect of subjectivity. Therefore, it is challenging to quantify purely and exclude qualitative aspects of the research, as it intrinsically depends on the individuals' perception.

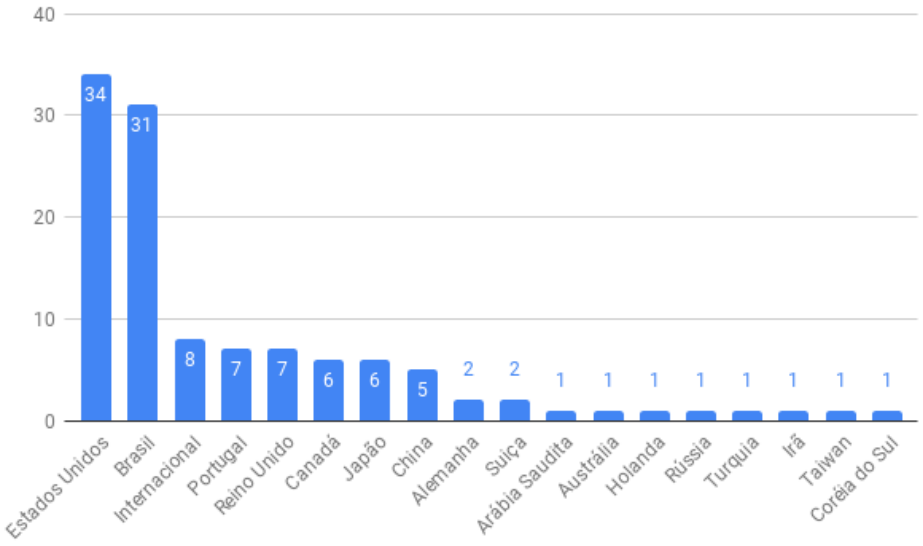
The exploratory type of research was present in 43.97% of the works, while the explanatory and descriptive types represented 31.03% and 25% of the works, respectively. Referring to the object of research, the field research showed 38.79% of participation, followed by the type of laboratory research, with 35.34%, with this percentage difference referring to four articles to the dominant one. Finally, with bibliographic research, with 25.86%.

The author's focus was mainly on the university (91.38%), followed by research centres (5.17%) and finally, companies (3.45%). The author's focus mapping was also present in works from two focuses (3.45%), as the union between universities and research centres or universities and companies.

In order to verify the significant countries that carry out research in the area and how these, in turn, relate to the researched countries, it is necessary to classify this information within this systematic review. Bringing the focus to colors, it is understood that the cultural visions themselves are one of the topics that must be taken into account when analyzing scientific publications in the area of color psychology, at the same time that these perceptions tend to be different from according to the social conventions widespread in each society (Elliot et al. 2007). Based on this, the country where each author carried out the research was identified, with the United States as predominant, with 34 studies, followed by Brazil, with 31 texts and international works, with eight studies (Figure 5).

[2] *S = survey; EC = case study; RL = Literature Review; PA = Analytical Research; EX = Experimental*

**Figure 5** – Number of studies carried out by each author's home country of research.



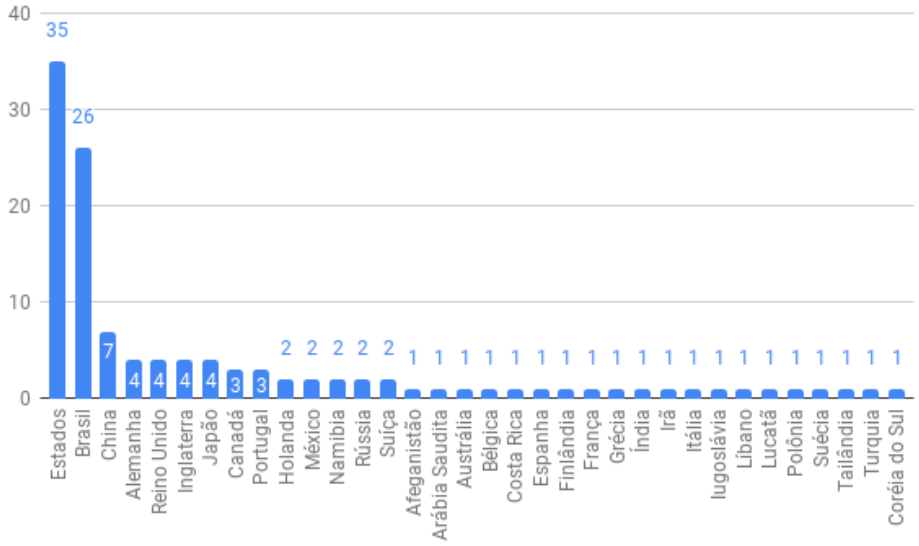

Source: Authors.

The texts classified as international, in turn, are derived from research by groups of authors of different nationalities and applied in several countries, that is, multi and transcultural works. As a consequence of the fact that part of the keywords of this research was applied entirely in Portuguese and, in turn, did not present a universal version (the search terms being: psychology of colors and psychology of colors dissertations), the results led to many works from Brazilians and Portuguese, influenced by the language.

Among the 116 mapped studies, 92 types of research focus on studying one or more countries; with this, the United States and Brazil still appear dominant in the researched countries, ahead with 35 and 26 researches, respectively (Figure 6). During the research, studies were identified that make comparisons between countries (5.43%), with this systematized as a country each of the countries surveyed in this type of research, that is, if research covers two countries, both were counted, since we recognize the two as having the same level of relevance.

In general, knowing the 118 countries surveyed, America presented the highest percentage level of the production of works, appearing within 55.93% of the surveys. Europe was investigated in 26.27%, followed by Asia, with 15.25% and, finally, the continents Africa, with 1.69% and Oceania, with 0.85%. However, when the aspect of categorization by continent focus of research is approached, Europe appears with a more significant number of countries, bringing 17 research focuses. Asia comes right after with nine countries, and only then America with six, at the same time, both Africa and Oceania were found with only one country that served as some research sample each.

**Figure 6** – Number of studies carried out by focus in countries.




Source: Authors.

It was observed, through another context, that 5.43% of the research included intercontinental comparisons. Three studies compare the context of 2 countries (the United Kingdom and Namibia; England and Namibia; and China and England). One study compares five countries (United States, Poland, Germany, Mexico and Russia), while one work has the perception of 22 countries as a comparative focus (United States, Afghanistan, Belgium, Costa Rica, India, Finland, France, Germany, Greece, Hong Kong, Iran, Italy, Japan, Lebanon, Mexico, Netherlands, Sweden, Thailand, Turkey, Yucatan, Spain and Yugoslavia).

### 3.4 Limitations and suggestions for future research

Intending to guide future research, we also sought to identify, through this systematic literature review, the limitations that occurred in past research in order to be able to delimit new paths, as well as new methodological approaches to achieve better results. Thus, beyond these limitations, the research prospects suggested by the texts found will also be discussed in this topic.

In order to have an idea of the most assertive paths to follow and the best methodology to be applied in future research, while observing the obstacles that did not allow better results, it is essential to understand the perceptions of researchers obtained through previous publications, identifying, thus, the points that can be improved. With this, it was possible to extract from 21 of the 116 scientific works the main weaknesses that occurred during the execution of the research (Table 3).

**Table 3** – Distribution of limitations described in the scientific works.

| Limitations | Authors |
|---|---|
| Individual/subjective perception of colors and shapes | Robison e Ward, 1995; Stepanova e Strube, 2009; Carneiro, 2012; Quattrer e Gouveia, 2013; Labrecque e Milne, 2012; Coar e Breland, 2001; Kim e Kim, 2019; Ikeda, 2020. |
| Evaluation methodology used | Robison e Ward, 1995; Stepanova e Strube, 2009; Jonauskaite, Althaus, Dael, Dan-Glauser e Mohr, 2018; Zhang, Bao e Xiao, 2019; Choi et al., 2020; Jonauskaite et al., 2020; Ikeda, 2020. |
| The sample size of people used in the survey | Trent, 1954; Kim e Kim, 2019; Pusnik, Podlesek, Nedeljoviç e Mozina, 2019. |
| Sociodemographic variables of the researched public | Hupka, Zaleski, Otto, Reidl e Tarabrina, 1997; Yu et al., 2020; Wan et al., 2020. |
| Impact of local culture on research | Hupka, Zaleski, Otto, Reidl e Tarabrina, 1997; Ikeda, 2020. |
| Color deficiency of respondents | Singh, 2006. |
| Amount of product analyzed | Deng, HuiJ e Hutchinson, 2010. |
| The profession of the surveyed public | Hupka, Zaleski, Otto, Reidl e Tarabrina, 1997. |
| Lack of research in a specific area | Carneiro, 2012. |
| Lack of representativeness of respondents | Carneiro, 2012. |
| Questionnaire application time | Carneiro, 2012. |
| The invasive content of the questionnaire questions according to the age group surveyed | Colaço, 2005. |
| Influence of screen contrast on color perception during testing | Ribeiro, 2011. |
| The number of quiz questions | Robison e Ward, 1995. |
| Variables used in the questionnaire | Robison e Ward, 1995. |
| Research developed on Instagram accounts, it is essential to check the number of followers of the analyzed profiles | Yu et al., 2020 |

Source: Authors.

It was noticed that the subjective factor that causes the individual perception of colors to overlap other factors, inherent to the element, proved to be an obstacle in the most significant number of studies that explain these limitations (Robison and Ward, 1995; Stepanova and Strube, 2009; Carneiro, 2012; Quattrer and Gouveia, 2013; Labrecque and Milne, 2012; Coar and Breland, 2001; Kim and Kim, 2019; Ikeda, 2020). This data is understandable, as it is noted that both the search for the universalization of chromatic perception and its means of overcoming the individuality present in this element are the main objectives of research in the area. That is, data that are difficult to quantify and analyze in a macro way, as they enter into social and human sciences issues, cultural, psychological, anthropological, semiotic, geographic topics, and dozens of other points of view involving phenomenology.

This ends up leading to the second main limitation point; the evaluation methodologies applied during the experiments did not present themselves exactly as the appropriate ways to effectively reach the propagated hypotheses (Robison & Ward, 1995; Stepanova & Strube, 2009; Jonauskaite et al., 2018; Zhang et al., 2019; Choi et al., 2020; Jonauskaite et al., 2020; Ikeda, 2020). The reading of the texts understood that the number of questions proposed in research that included

questionnaires in their methodology ended up being unsatisfactory at the time of analysis of the results, not deepening or not being sufficient to answer the research question that guided the study.

Also, in this sense, the quantitative universe of research sampling sometimes becomes a limiting variable to arrive at the most effective and complete results. When dealing with this issue in color research, it sees it through a double path, at the same time that, as a consequence of the perception of color not being a universal object, a substantial sample, in turn, can make the research confusing. In contrast, a minimal amount can turn the research into superficial and non-validated, precisely the challenges faced by researchers who put research sampling as limitations.

Among the other limitations, it is worth emphasizing the importance of identifying color deficiency in survey respondents, as brought by Singh (2006) within the limitations of his work, as an essential point to keep in mind when applying the survey. For, individuals who, in turn, have this condition, directly interfere in the final result of the work, since they do not tend to see the chromatic spectra in the same way as the others and in this way, it is not possible, by the researcher, to measure how the same he sees the stimuli placed before him. One solution becomes the application of the test of Ishihara (1994).

Prospecting new and more in-depth results in color research, some works suggest some possible paths to be followed. As a result, 44 of the 106 surveys mapped denote investigations of surveys yet to be carried out (Table 4).

**Table 4** – Distribution of suggestions for future research.

| Future research | Authors |
|---|---|
| The relationship between color and marketing areas | Crowley, 1993; Labrecque, Patrick e Milne, 2013; Gorn, Chattopadhyay, Yi e Dahl, 1997; Singh, 2006; Abbade e Ramos, 2008. |
| Replicate the study with other research instruments | Robison e Ward, 1995; Melara, 1989; Kim e Kim, 2019; Zhang, Bao e Xiao, 2019; Pusnik, Podlesek, Nedeljkoviç e Mozina, 2019. |
| Replicate the study with other colors | Dreiskaemper, Strauss, Hagemann e Büsch, 2013; Puccinelli, Chandrashekaran, Grewal e Suri, 2013; Bellizzi e Hite, 1992; Wan et al., 2020; Choi et al., 2020; Hagtvedt, 2020. |
| Application of the methodology in more countries/cultures | Kaya e Epps, 2004; Taylor, Clifford e Franklin, 2013; Trent, 1954; Wan et al., 2020; Tham et al., 2020; Ikeda, 2020. |
| The relationship between cultural language and color/shape | Clifford, Holmes, Davies e Franklin; 2010; Pitchford e Mullen, 2001; Horiguchi e Iwamatsu, 2018. |
| Larger samples | Hemphill, 1996; Trent, 1954; Abbade e Ramos, 2008. |
| Comparison with other works | Campos, 2009; Abbade e Ramos, 2008. |
| Delving deeper into the physiology of color vision | Adams e Osgood, 1973; Elliot e Maier, 2007; Jonauskaite et al., 2020. |
| Use other variables in the questionnaire | Kaya e Epps, 2004; Hagtvedt, 2020. |
| Study color in another aspect | Meier, D'Agostino, Elliot, Maier e Wilkowski, 2012. |
| Auditory and olfactory perception | Colaço, 2005. |
| Testing the results suggested in the survey | Shelly, 1967. |
| Duration of primary color perception | Elliot e Maier, 2007. |
| The perception of value given to color by customers | Labrecque e Milne, 2012. |
| How the background of each era affects color perception | Horiguchi e Iwamatsu, 2018. |
| The relationship between the emotions projected in the colors and the environment | Adams e Osgood, 1973. |

| | |
|---|---|
| The origin of beliefs used in colors | Adams e Osgood, 1973; |
| Study colors in line with other colors | Kaya e Epps, 2004. |
| The degree of relationship between color and desirability in foods | Koch e Koch, 2003. |
| The relationship between color preference in consonance and the environment | Schloss, 2011. |
| Test with other products | Bellizzi e Hite, 1992. |
| Emotional meaning projected on skin color | Coar e Breland, 2001. |
| Skin color perception and preference | Coar e Breland, 2001. |
| Mathematical model about the theory of color preference | Gong, Wang, Hai e Shao, 2017. |
| Comparison of colors and color preferences through a system | Eicher, Deker e Shipley. 1964. |
| Practical application of theory | Oyama, Taaaka e Chiba, 1962. |
| Study the relationship between music and color | Jonauskaite, Althaus, Dael, Dan-Glauser e Mohr, 2018. |
| Deepen studies in the field of color psychology in digital games | Roohi e Forouzandehb, 2019. |
| How color relates to other graphic elements | Tokutake, Kajiyama e Ouchi, 2019. |
| Increase the level of complexity of the research instrument | Souza e Junior Arrais, 2019. |
| Create a search tool to buy the different color effects | Yu et al., 2020. |

Source: Authors.

Studying the application of colors in marketing appeared in 5 works, being the suggests that was most repeated; its relevance is centred on the fact that, as Guo et al. (2020) explains, color is responsible for 90% of the primary contact of human-surface interaction, thus, an essential element when talking about design aimed at the visceral sense of experience and interaction with artefacts and advertising pieces. With this, the exploration of color to the marketing area dismantles ways of innovation and consequently greater profitability. So far, Sliburyte and Skeryte (2014) comment and corroborate the scarcity of works in the marketing literature regarding color research.

Soon after, with the same amount of work as the previous one, the authors then suggested changing the research instrument to identify the behavior of the variables. Through the understanding of the subjectivity of research in colors, it can be seen, in the meantime, that changes, even if small, can indicate significant changes in the final results found, which can generate critical comparative debates between the projects.

Among the studies with the fewest suggestions, it is emphasized, with three works, the replication of the methodology in different countries for comparison purposes, a method also important when working with colors, since the so-called cross-cultural research adds contributions that debate the differences of color perceptions across cultures, showing their differences and analogies. It is one of the most prominent and ancient areas when it comes to color studies because, as Farina, Perez and Bastos (2006, p. 14) explain, “Even the study of the laws that govern the domain of color is somehow linked to the psychological context and, consequently, is not universal”.

Then comes the replication of the study with other chromatic hues and expansion of the research sample, both to understand the existing differences through the manipulation and to deepen between the studied objects of study. Finally, there is still the study of the relationship between colors and linguistics, which also correlates with cross-cultural research, as it brings discussions about the nomenclature given to pigments and chromatic light rays and their existence.

## 4. Final Considerations

In order to understand how studies in the field of color psychology were developed and contribute to an extensive study on the current state of the art, the scientific works published until the year 2020 were mapped and systematized using the systematic bibliography review method. The methodology used led the research to map 116 texts, from scientific articles, through dissertations and theses, which comprised the corpus of analysis of this work.

As a result, the systematic review showed a much greater interest in studies in color psychology in the last 14 years than the previous ones. Those results showed a more significant search from 2006 onwards and remained constant at this level of interest, with an approximate average of 4 articles per year, reaching its apex in 2020. It demonstrates a growing interest in research in the area and recognizes its scientific and social potential.

The study did not identify any journal with a significant number of publications. However, Color Research and Application was the platform that presented the most significant number of works. Still, it could be seen that the journals that receive the most publications in the area come from psychology. These results indicate high dissemination through sharing platforms, which causes studies to be mainly spread among journals. Another phenomenon identified was that the second theme of the research that beyond color becomes the area where the study will be shared, making it difficult for people in the area of color to see it.

The central studies found are experimental and case studies, with greater prominence of a qualitative and exploratory approach. The United States and Brazil are the countries that presented the most research in color psychology, but cross-cultural studies were also found in collaboration with authors from different countries. Investigations occurred in 118 countries were identified, focusing more on continents such as the Americas, Europe and Asia.

The development of the present work becomes relevant by favoring the delivery of information about the main points debated in research in one of the areas that focus on colors. This is distinguished by bringing a quantitative approach, thus allowing the identification of less discussed topics to generate studies focused on them and the development to become more directed to areas not yet covered, working with the principles of differentiation and innovation.

By having a high characteristic of subjectivity, studies of color development are limited mainly to this bias, preventing research from achieving greater or more generalizable results. During the study, new topics emerged to be researched, including applying colors in marketing, applying the same methodology researched in different countries for comparative purposes, and replicating a study with other color variants. With this, it is shown that even though it is an area that has been studied for a long time, there are favorable research prospects and promising technological development.

For future research, the authors of this article indicate the deepening in areas with little research, mainly focusing on investigations with the elderly. In addition, we also perceived it to be relevant to study the effect of colors on emotions and human cognition and explain how this can be reversed for the development of products and marketing strategies. In this way, for future investigations, it is essential to focus on the practical explanation of how color studies can be taken to the civil, business and industrial community, improving processes.

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