

## THE PSYCHOLOGICAL MEANING OF COLOR IN DESIGN: A SEMANTIC REVIEW\*

DOI:10.24234/miopap.v12i1.64

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### Abstract

Color is a fundamental and pervasive element of human perception and a critical tool in various design disciplines. This review synthesizes the scientific literature on the psychological meaning of color within design contexts, encompassing graphic, web, interior, product, and marketing design. The study examines how color influences human emotion, cognition, and behavior, drawing upon theoretical frameworks ranging from biological and evolutionary perspectives to learned associations and context-dependent models, particularly the Color-in-Context theory. The methodology involved a systematic review of peer-reviewed journal articles, academic books, and conference proceedings, focusing on empirical research employing experimental, correlational, survey, and qualitative methods. Key findings indicate that colors such as red, blue, green, yellow, black, and white evoke complex, often dualistic psychological responses (e.g., red signifies both passion and danger; blue conveys trust but also sadness). These responses are significantly moderated by factors including the specific design context, cultural background, individual differences (age, gender, personality, experience), and the interplay of color combinations, saturation, and brightness. Methodological limitations within the field, such as inadequate color specification and control, underpowered samples, and oversimplification of stimuli, are identified. Practical implications for design professionals highlight the need for nuanced, evidence-based color strategies that consider context, target audience, and brand identity, alongside ethical considerations regarding potential manipulation and accessibility. The review concludes that while color demonstrably affects psychological functioning, the field requires further research with improved methodological rigor, a greater focus on moderating variables and complex color interactions, and the development of mid-level theories to bridge the gap between fundamental research and effective design application.

**Keywords:** color psychology, design, perception, emotion, cognition, behavior, culture, context, color theory, human-computer interaction (HCI).

## 1. INTRODUCTION

### 1.1. The Pervasive Influence of Color in Human Experience and Design

Color is an inescapable dimension of human visual experience, fundamentally shaping how individuals perceive and interact with their environment. It is far more than an aesthetic overlay; color functions as a powerful, non-verbal communication tool capable of signaling action,

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influencing mood, altering perception, and even triggering physiological reactions (Rider, 2009). Its ubiquity extends across virtually every field of design, including graphic design, web and user interface (UI) design, interior design, product design, marketing, branding, and architecture (Sanvicente, 2024).

The initial encounter with color can have a remarkably swift and significant impact. Research suggests that individuals form judgments about products or people within as little as 90 seconds of initial viewing, and that color alone can account for up to 90% of this assessment. This rapid evaluation underscores the profound role color plays in establishing first impressions and highlights its potential economic implications for design effectiveness, branding, and product success. The sheer speed and weight of these color-based judgments strongly suggest that many psychological effects of color operate below the threshold of conscious awareness. Such rapid, high-impact assessments are unlikely to result from deliberate, analytical thought processes. Instead, they point towards automatic, associative, or affective mechanisms driving initial perception, often preceding more detailed cognitive evaluation. This largely subconscious influence is the source of color's potency as a design element, but it simultaneously introduces ethical considerations regarding its potential use for manipulation (Rauten, 2024).

### **1.2. Defining Color Psychology in the Context of Design**

Color psychology is the scientific study of how hues (colors) and their properties (such as saturation and brightness) affect human cognition, affect (emotions and moods), behavior, and even physiological states (Cherry, 2024). It is an inherently interdisciplinary field, drawing insights from psychology, neuroscience, vision science, anthropology, sociology, marketing, art history, and various design disciplines (Hussain, 2021). Within the context of design, color psychology moves beyond mere aesthetics to investigate the measurable impacts of color choices on user or consumer responses. This includes effects on mood states, attention span, task performance, decision-making processes, brand perception, product evaluation, and physiological reactions such as changes in heart rate, blood pressure, and alertness levels (Arora & Warsi, 2024).

### **1.3. Historical Context and Evolution of Research**

While the systematic study of color psychology is relatively recent, human fascination with color and intuition about its effects date back centuries. Early explorations were often philosophical or artistic. Johann Wolfgang von Goethe, in his *Theory of Colors* (1810), diverged from Isaac Newton's purely physical description of the light spectrum to propose links between color categories (e.g., "plus" colors like yellow and red-yellow) and emotional responses such as warmth and excitement (Mirzaei, 2025).

As psychology emerged as a distinct discipline, researchers began investigating color's effects

more formally. Kurt Goldstein (1942), building on Goethe's ideas and observations of patients, hypothesized that colors like red and yellow produce inherent physiological reactions manifesting as distinct emotional, cognitive, and behavioral patterns (e.g., arousal, outward focus, forceful action) (Unika Vaev, n.d.). Lois B. Wexner (1954) empirically explored associations between specific hues and mood-tones, finding consistent links. The mid-20th century saw figures like Faber Birren bridge the gap between artistic practice and scientific inquiry, authoring influential works that helped formalize the field.

The past decade, in particular, has witnessed a surge in research interest (Elliot, 2015). This contemporary work integrates insights from neuroscience (e.g., neuroaesthetics exploring brain responses to color), develops more sophisticated theoretical models like the Color-in-Context theory, and increasingly focuses on applied contexts such as marketing, branding, and human-computer interaction (HCI).

#### 1.4. Overview of Major Theoretical Frameworks

Several theoretical perspectives attempt to explain how color influences psychological functioning. These can be broadly categorized:

- **Biological/Evolutionary Perspectives:** These theories propose that some responses to color are rooted in our biology or evolutionary history.

- *Wavelength Effects:* Early theories posited that the physical properties of light wavelengths directly impact physiology and emotion. Longer wavelengths (red, yellow) are often described as arousing, stimulating, or warm, while shorter wavelengths (blue, green) are seen as relaxing, calming, or cool. More recent work focuses on specific pathways, such as blue light's activation of the melanopsin system, which influences alertness and attention.

*Ecological Valence Theory (EVT):* Proposed by Palmer and Schloss (2010), EVT suggests that color preferences are not arbitrary but develop based on an individual's cumulative emotional responses to objects and environmental events associated with those colors (Khattak et al., 2021). For example, the common adult preference for blue might stem from positive associations with clear skies and clean water, while a dislike for brownish-yellow might relate to associations with decay or feces. This theory helps explain why preferences can change with age and experience.

- *Comparative Approaches:* Some theories draw parallels between human and non-human animal responses. For instance, the display of red (associated with oxygenated blood) signals dominance or health in many species, potentially explaining why red enhances perceived dominance or competitiveness in humans. Relatedly, the evolution of human trichromatic vision may be linked to detecting subtle skin color changes (redness, yellowness) that signal health, emotion, or attractiveness (Elliot et al., 2007).

● **Learned Association Perspectives:** These frameworks emphasize the role of learning and experience in shaping color meaning.

○ *Social Learning/Classical Conditioning:* Many color associations are believed to arise through repeated pairings of a color with specific concepts, messages, or experiences within a culture or environment. Examples include red with stop signs or errors, green with nature or traffic lights, white with weddings in Western cultures, or black with mourning (Lin, Mottaghi, & Shams, 2024). These learned associations become deeply ingrained and can trigger automatic responses.

○ *Conceptual Metaphor Theory:* This theory posits that humans use concrete perceptual experiences, like color, to understand abstract concepts metaphorically. Common linguistic expressions reflect these links (e.g., "seeing red" for anger, "feeling blue" for sadness, "green with envy," associating lightness with positivity or goodness). These metaphors can influence judgments and social perceptions.

● **Contextual Perspectives:** Recognizing the limitations of universal associations, these theories emphasize the situation-dependent nature of color meaning.

○ *Color-in-Context Theory:* Proposed by Elliot and Maier (2012), this influential theory integrates biological predispositions and social learning but adds a crucial layer: context. It argues that the psychological meaning and subsequent effect of a color are fundamentally dependent on the physical and psychological context in which it is perceived. The same color can evoke vastly different, even opposite, responses depending on the situation. For example, red might enhance attractiveness in a romantic context but impair performance in an achievement context where it signals failure or danger. Similarly, blue might signal trustworthiness on a corporate logo but indicate spoilage on food (Elliot et al., 2007).

The evolution of these theoretical frameworks reveals a clear trajectory away from simplistic, universal claims about color meaning towards more sophisticated models. These newer models acknowledge the complex interplay between innate biological factors, extensive learning through cultural and personal experience, and, most critically for design, the specific context of perception. The Color-in-Context theory appears particularly pertinent, offering a framework to understand the often-contradictory findings in the literature and aligning well with the inherently contextual nature of design practice, where the function, audience, and surrounding elements drastically alter how a color is deployed and interpreted (Design Studio UI/UX, 2024).

### 1.5. Rationale and Objectives of the Current Review

Despite the recent surge in research activity, the field of color psychology, especially concerning its application in design, remains in a nascent stage of development. The literature is often characterized as fragmented, containing methodological weaknesses, and exhibiting a

significant gap between fundamental theoretical understanding and practical, evidence-based design implementation. Designers and marketers require robust knowledge about how color impacts human psychology to improve communication and user engagement, yet clear, synthesized guidance grounded in rigorous science is often lacking.

Therefore, this review aims to address this gap by providing a comprehensive, critical synthesis of the scientific literature on the psychological meaning of color specifically within the diverse contexts of design. The objectives are:

1. To systematically review and synthesize peer-reviewed literature concerning the psychological meaning—encompassing affective, cognitive, and behavioral responses—of color within various design domains (graphic, web/UI, interior, product, marketing, etc.).
2. To critically analyze the methodologies commonly employed in color psychology research relevant to design, evaluating their strengths and limitations.
3. To evaluate the evidence regarding the influence of key moderating variables, including context, culture, individual differences, and the effects of color combinations and properties (saturation, brightness).
4. To discuss the practical implications, potential applications, and ethical considerations arising from color psychology research for design professionals.
5. To identify current limitations, inconsistencies, and gaps in the existing body of knowledge, and to propose specific directions for future research that can advance the field and its applicability to design.

## **2. METHODS (LITERATURE REVIEW METHODOLOGY)**

This review employed a systematic approach to identify, evaluate, and synthesize relevant academic literature on the psychological meaning of color in design.

### **2.1. Search Strategy**

A comprehensive search was conducted across multiple academic databases, including PsycINFO, PubMed, Scopus, Web of Science, and Google Scholar. Additionally, relevant archives for design and human-computer interaction research, such as the ACM Digital Library and IEEE Xplore, were consulted. The search utilized combinations of keywords and subject terms, including: "color psychology", "colour psychology", "color meaning", "color perception", "affective response color", "cognitive effects color", "behavioral effects color", "color design", "graphic design", "web design", "UI design", "interior design", "product design", "marketing color", "branding color", "color theory", "color context", "cultural color", "color preference", "color harmony", as well as specific color names (e.g., "red", "blue", "green", "yellow", "black", "white"). While the primary

focus was on research published within the last 20-25 years to capture contemporary theories and methodologies, seminal works foundational to the field were included for historical context.

## 2.2. Inclusion and Exclusion Criteria

Studies were included if they met the following criteria: (a) published in peer-reviewed journals, academic books or book chapters, or rigorously reviewed conference proceedings; (b) investigated psychological responses (affective, cognitive, or behavioral) to color; (c) focused on contexts relevant to design or presented findings with clear implications for design; (d) employed empirical research methods (e.g., experimental, correlational, survey, qualitative, mixed-methods) or were systematic reviews of such research; and (e) were available in English. Exclusion criteria included: (a) non-academic sources; (b) studies focusing solely on physical/physiological aspects without psychological relevance; (c) research exclusively on clinical color therapy; (d) abstracts only; and (e) non-English publications.

## 2.3. Data Extraction and Synthesis Approach

A narrative synthesis approach was adopted (De Medeiros Dantas et al., 2022). Key information was extracted from each source, including: author(s)/year; theoretical framework; objectives; methodology (design, participants, stimuli, measures); core findings on color effects (specific colors, moderators); limitations; and design relevance. Information was organized thematically according to the IMRAD structure, focusing on converging evidence, inconsistencies, and overall patterns.

## 2.4. Methodological Quality Assessment

The methodological rigor of included empirical studies was assessed based on criteria relevant to color psychology. Key criteria included: clarity of color specification (e.g., standardized coordinates); control of viewing conditions (illumination, background); sample characteristics and size; validity of measures (scales, tasks); control for confounds; and transparency/reproducibility.

# 3. RESULTS (SYNTHESIZED FINDINGS FROM LITERATURE)

This section synthesizes the empirical findings from the reviewed literature, focusing first on the psychological effects associated with core colors frequently utilized in design, and second on an analysis of the research methodologies employed in these studies.

## 3.1. Empirical Findings on Core Colors in Design Contexts

The literature reveals complex and often multifaceted psychological associations and effects for key colors. These are summarized below, emphasizing findings relevant to design applications.

### ●3.1.1. Red:

○ *Associations:* Red consistently evokes strong, often dualistic associations: positive (passion,



excitement, energy, love, power, confidence, warmth) and negative (danger, anger, aggression, warning, errors, failure, intensity) (Rocky Mountain College of Art + Design, 2025).

◦ *Affective/Physiological Responses*: Red is physiologically arousing, increasing heart rate and alertness. It is linked to appetite stimulation. Overuse can cause anxiety or agitation (Insights Psychology, 2025).

◦ *Cognitive/Behavioral Impacts*: Red effectively captures attention (Bytyçi, 2020). It signals urgency (used for CTAs, warnings, sales). Perception of red before achievement tasks can impair performance (Unika Vaev, n.d.), potentially due to failure associations. Conversely, in affiliation contexts, red can enhance perceived attractiveness. It is linked to perceived dominance. Some evidence suggests red aids memory (Hecks, 2025).

#### ●3.1.2. Blue:

◦ *Associations*: Blue is overwhelmingly associated with positive concepts like calmness, serenity, stability, trust, reliability, security, professionalism, and wisdom. It also carries associations with sadness ("feeling blue"), coldness, and aloofness.

◦ *Affective/Physiological Responses*: Blue generally induces relaxation and calmness. Physiologically, it's linked to lowered blood pressure/heart rate (Rockfon, 2022). Blue light exposure can increase alertness. Blue is frequently reported as the most preferred hue.

◦ *Cognitive/Behavioral Impacts*: Blue enhances perceptions of trustworthiness and competence, widely used in corporate branding (finance, tech). It may enhance concentration and productivity. In UI design, it fosters a calm, secure experience (Design Studio UI/UX, 2024).

#### ●3.1.3. Green:

◦ *Associations*: Green holds strong associations with nature, growth, health, harmony, balance, tranquility, safety, and environmentalism. Negative associations include envy, sickness, and boredom (Insights Psychology, 2025). Green-yellow shades are often perceived negatively (Appear Online, 2025).

◦ *Affective/Physiological Responses*: Green is widely considered calming and relaxing, reducing stress. It may lower blood pressure/heart rate.

◦ *Cognitive/Behavioral Impacts*: Green can promote balance and security. Research suggests it enhances creativity, focus, and memory, and reduces mental fatigue. It's frequently used in branding for health, wellness, and eco-friendly products. Its presence in work/learning environments is considered beneficial (Springer, 2022).

#### ●3.1.4. Yellow:

*Associations*: Yellow is strongly linked to happiness, optimism, warmth, energy, and creativity (Sanvicente, 2024). Negative connotations include caution, warning, cowardice, anxiety,

and sickness (especially green-yellow). Yellow is often among the least preferred colors by adults.

◦ *Affective/Physiological Responses*: Yellow is perceived as energetic and stimulating. Its high luminosity can cause visual fatigue. Overexposure has been anecdotally linked to increased frustration (Cherry, 2023).

◦ *Cognitive/Behavioral Impacts*: Yellow is highly visible and attention-grabbing, used in warning signs and highlights. It may stimulate mental processes (Jandal, 2024). Yellow often presents readability challenges. In branding, it conveys youthfulness and fun (e.g., McDonald's) (Varma, 2024).

#### ●3.1.5. Black:

◦ *Associations*: Black is strongly associated with power, sophistication, elegance, luxury, authority, and mystery. Negative connotations include death, evil, mourning, fear, sadness, and aggression (World Design Council, 2024).

◦ *Affective/Physiological Responses*: Often evokes negative emotions. Extensive use can feel oppressive or make spaces appear smaller (Kaya & Epps, 2004).

◦ *Cognitive/Behavioral Impacts*: Black is used in luxury branding (fashion, tech) to convey elegance and premium quality. Its association with aggression is observed in sports. Black backgrounds can enhance adjacent colors (Morton, n.d.). Black may be least effective for memory retention.

#### ●3.1.6. White:

◦ *Associations*: White is predominantly associated with purity, cleanliness, simplicity, peace, goodness, and modernity. Negative associations include sterility, coldness, and emptiness. In some Eastern cultures, it symbolizes mourning.

◦ *Affective/Physiological Responses*: Generally, elicits positive emotional responses. Can create feelings of freshness. Bright white can cause glare and visual fatigue (Dacillo, n.d.).

◦ *Cognitive/Behavioral Impacts*: White is a cornerstone of minimalist design, creating spaciousness and clarity. In branding, it signifies simplicity and sophistication (e.g., Apple). White backgrounds enhance visibility of other colors.

#### ●3.1.7. Other Significant Colors (Briefly):

◦ *Orange*: Energetic, enthusiastic, warm, creative, attention-grabbing. Can seem cheap.

◦ *Purple*: Luxury, royalty, wisdom, creativity, mystery. Can imply snobbery.

◦ *Pink*: Softness, romance, femininity, calmness. Can connote weakness.

◦ *Brown*: Earthiness, stability, reliability, comfort. Can appear dull.

◦ *Gray*: Neutrality, balance, calmness, sophistication. Can seem dull or depressing (Iyer, 2023).



The consistent finding of dualistic (positive/negative) interpretations for nearly every color strongly supports context-dependent frameworks like the Color-in-Context theory. Meaning is constructed based on context, combinations, culture, and experience, necessitating a nuanced design approach.

(Table 1: Summary of Psychological Effects of Key Colors in Design Contexts)

| Color | Common Positive Associations/Emotions                              | Common Negative Associations/Emotions              | Key Cognitive/Behavioral Effects (Examples in Design)                                                                                                                                                  |
|-------|--------------------------------------------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Red   | Passion, excitement, energy, love, power                           | Danger, anger, aggression, warning, error, failure | Grabs attention, signals urgency (CTAs, sales), stimulates appetite (food branding), impairs cognitive task performance (achievement context), enhances attraction (mating context), signals dominance |
| Blue  | Calmness, trust, stability, reliability, security, professionalism | Sadness, coldness, aloofness                       | Builds trust (corporate/financial/tech branding, UI), promotes relaxation (interiors, healthcare), may enhance concentration/productivity, generally preferred hue                                     |
| Green | Nature, growth, health, harmony, balance, tranquility, safety      | Envy, sickness, boredom, inexperience              | Calming/reduces stress (interiors, wellness design), enhances creativity/focus                                                                                                                         |

|               |                                                                   |                                                                              |                                                                                                                                                       |
|---------------|-------------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |                                                                   |                                                                              | (work/learning spaces),<br>signals eco-<br>friendliness/health<br>(branding)                                                                          |
| <b>Yellow</b> | Happiness, optimism,<br>warmth, energy,<br>creativity             | Caution, warning,<br>cowardice, anxiety,<br>frustration, sickness.           | Highly visible/attention-<br>grabbing (warnings,<br>highlights), can cause eye<br>fatigue, difficult<br>readability, conveys<br>youth/fun (branding)  |
| <b>Black</b>  | Power, sophistication,<br>elegance, luxury,<br>formality, mystery | Death, evil, mourning,<br>fear, sadness,<br>oppression, aggression           | Conveys luxury/premium<br>quality (branding),<br>associated with aggression<br>(sports), can make spaces<br>feel smaller, enhances<br>adjacent colors |
| <b>White</b>  | Purity, cleanliness,<br>simplicity, peace,<br>modernity, safety   | Sterility, coldness,<br>emptiness, isolation,<br>mourning (some<br>cultures) | Creates sense of space,<br>foundation of minimalist<br>design, conveys<br>simplicity/tech (branding),<br>can cause glare/eye strain                   |

*Note: Associations and effects are highly context-dependent.*

### 3.2. Analysis of Research Methodologies Employed

The empirical study of color psychology utilizes a range of research methodologies, each with strengths and weaknesses.

#### ○ **Prevalence of Methodologies:**

○ *Experimental Designs:* Frequently used to investigate causal links between color stimuli and responses (e.g., color effects on test performance, UI engagement, physiological measures , VR environments, cognitive tasks ).

*Correlational Research:* Identifies statistical associations without manipulation (e.g., personality and color preference (Xia et al., 2021), color-emotion links (World Design Council,

2024). Limited by inability to establish causation (Eriksen Translations, 2020).

- *Surveys and Questionnaires*: Common for assessing subjective responses (preferences, emotions, attitudes) using various scales (ranking, Likert, semantic differential, SAM (World Design Council, 2024).

- *Qualitative and Mixed Methods*: Provide deeper insights via interviews, focus groups, thematic analysis (Mirzaei, 2025). Mixed methods combine approaches (Mirzaei, 2025).

- *Observational and Archival Methods*: Less common; involve naturalistic observation or analysis of existing data (e.g., logo colors, sports outcomes) (Eriksen Translations, 2020).

- **Methodological Strengths and Limitations**: Experiments offer causal inference but may lack ecological validity. Correlational studies explore natural relationships but cannot determine causation. Surveys are efficient but rely on potentially biased self-reports (Eriksen Translations, 2020). Qualitative methods offer depth but limited generalizability.

- **Specific Methodological Critiques in Color Psychology Literature**: Recurring criticisms include (Rider, 2009):

- *Inadequate Color Specification*: Frequent failure to precisely define stimuli using standardized systems (Munsell, CIE L\*a\*b\*, sRGB) or spectral data, hindering replication and comparison (Rider, 2009).

- *Lack of Control Over Viewing Conditions*: Poor control/reporting of ambient lighting, backgrounds, viewing distance, screen calibration (Elliot, 2015).

- *Insufficient Statistical Power*: Small sample sizes increase error risk and potentially inflate effect sizes (Elliot, 2015).

- *Limited Ecological Validity of Stimuli*: Over-reliance on simple abstract stimuli (colored squares) may not generalize to complex design contexts (Park University, 2024).

- *Ambiguity of Concepts*: Lack of consistent operational definitions for terms like "color harmony" (Arora & Warsi, 2024).

- *Narrow Focus on Hues*: Disproportionate focus on basic hues (esp. red), neglecting saturation and brightness (Elliot, 2015).

**(Table 2: Methodological Approaches in Color Psychology Research)**

| Methodology Type | Description  | Example Study Focus | Key Strengths | Key Limitations/Critiques |
|------------------|--------------|---------------------|---------------|---------------------------|
| Experimental     | Manipulation | Effect of red       | Strongest for | Potential artificiality;  |

|                                  |                                                                             |                                                                                                              |                                                                                                   |                                                                                                                                      |
|----------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
|                                  | of color variables to determine causal effects on responses.                | on test performance (Elliot et al., 2007); Color scheme impact on UI engagement (Mirzaei, 2025).             | causal inference; Allows variable control.                                                        | Difficulty in color control; Ethical constraints (Eriksen Translations, 2020); Limited ecological validity (Park University, 2024) . |
| <b>Correlational</b>             | Observation and measurement of statistical relationships between variables. | Color preference and personality (Xia et al., 2021); Color-emotion associations (World Design Council, 2024) | Explores natural relationships; Useful when experiments impractical (Eriksen Translations, 2020). | Cannot infer causation; Third-variable problems; Dynamic relationships (Eriksen Translations, 2020).                                 |
| <b>Survey/<br/>Questionnaire</b> | Collection of self-reported data on preferences, attitudes, emotions.       | Assessing color preferences (Rider, 2009); Measuring emotional responses (Kaya & Epps, 2004).                | Efficient for large samples; Good for subjective states; Various scales (Unika Vaev, n.d.).       | Reliance on self-report (biases); Limited depth; Sensitive to format (Eriksen Translations, 2020); May miss unconscious effects.     |
| <b>Qualitative</b>               | In-depth exploration of experiences,                                        | Understanding reasons for color choices                                                                      | Rich, contextual understanding;                                                                   | Findings often not generalizable; Subjectivity; Time-                                                                                |

|                                |                                                                           |                                                                                        |                                                                        |                                                                                                     |
|--------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
|                                | meanings via interviews, focus groups.                                    | (Swasty & Adriyanto, 2017); Exploring cultural meanings.                               | Explores complexity; Generates hypotheses.                             | consuming.                                                                                          |
| <b>Mixed Methods</b>           | Integration of quantitative and qualitative approaches.                   | Experiment + qualitative analysis (Mirzaei, 2025).                                     | Comprehensive understanding; Triangulation.                            | Complex design/implementation; Requires diverse expertise; Data integration challenges.             |
| <b>Archival/ Observational</b> | Analysis of existing data or observation of behavior in natural settings. | Analyzing branding color trends; Observing color choices (Eriksen Translations, 2020). | High ecological validity (observation); Uses existing data (archival). | Limited control; Causality difficult; Observer bias; Data limitations (Eriksen Translations, 2020). |

*Note: This table summarizes common approaches and their general characteristics within color psychology research relevant to design.*

## 4. DISCUSSION

The synthesized findings confirm color's potent influence in design on affect, cognition, and behavior, but reveal a complexity beyond popular portrayals.

### 4.1. Interpretation and Synthesis of Findings

Colors like red, blue, green, yellow, black, and white carry associations triggering measurable responses (Arora & Warsi, 2024). Red's arousal (Mirzaei, 2025), blue's calmness (Mirzaei, 2025), red/yellow's attention-grabbing nature (Insights Psychology, 2025), and blue's link to trust (World Design Council, 2024) are recurring themes relevant to design.

However, effects are rarely simple. The dualistic associations (Red: passion/danger; Blue: trust/sadness) highlight that meaning is constructed, not inherent. This complexity aligns with

contemporary theories. While basic physiological responses (warm vs. cool) or universal experiences (EVT (Rider, 2009) explain some tendencies, they fail to capture context-specific and cultural meanings. The Color-in-Context theory (Unika Vaev, n.d.), emphasizing situation-dependent interpretation, provides a robust framework, explaining contradictory findings (e.g., red's opposing effects in achievement vs. affiliation). Context acts as a primary filter, modulating or determining color's psychological impact in design.

## 4.2. Influence of Moderating Variables

Variability necessitates examining moderating factors.

●**4.2.1. The Critical Role of Context:** As per Color-in-Context theory (Unika Vaev, n.d.), the situation (physical and psychological) is paramount. Red's negative impact on cognitive tasks occurs in achievement contexts (failure priming (Elliot, 2015), while it enhances attraction in romantic contexts (Unika Vaev, n.d.). Blue's effectiveness depends on appropriateness (trust for a bank, less so for fast food) (Rocky Mountain College of Art + Design, 2025). Perceived *appropriateness* of color to brand/product context can be more influential than inherent associations (Design Studio UI/UX, 2024). Designers need deep analysis of the use case (user expectations, culture, brand personality, function) rather than applying simple rules.

●**4.2.2. Cultural Variations and Universals:** There's interplay between potential universals (blue preference (Rider, 2009), warm/arousing vs. cool/calming distinction (Arora & Warsi, 2024) , bright=positive/dark=negative link (Rider, 2009) and profound cultural differences in symbolic meaning (Arora & Warsi, 2024). These learned meanings (Red: luck in China, danger in West; White: purity in West, mourning in East Asia (Insights Psychology, 2025) demand cultural sensitivity in global design (Rocky Mountain College of Art + Design, 2025). Designers should acknowledge basic affective responses but prioritize learned, culturally specific meanings relevant to the audience.

(Table 3: Cross-Cultural Color Symbolism Examples Relevant to Design)

| Color | Western Associations (Examples)            | East Asian Associations (Examples) | Latin American Associations (Examples) | Middle Eastern/Islamic Associations (Examples) | Design Implications/Cautions                                                |
|-------|--------------------------------------------|------------------------------------|----------------------------------------|------------------------------------------------|-----------------------------------------------------------------------------|
| Red   | Passion, love, excitement, energy, danger, | Luck, prosperity, happiness        | Passion, religion (with white), death, | Danger, caution (Eriksen Translations,         | Meaning varies widely; potent but requires careful cultural research. Avoid |



|               |                                                                                                 |                                                                                           |                                                                          |                                                   |                                                                                                                                                   |
|---------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
|               | urgency (Rocky Mountain College of Art + Design, 2025)                                          | (China); Anger, danger (Insights Psychology, 2025)                                        | vibrancy (region varies) (Alnasuan, 2016)                                | 2020)                                             | assuming universal meaning of urgency/passion.                                                                                                    |
| <b>White</b>  | Purity, weddings, cleanliness, simplicity, peace (Rocky Mountain College of Art + Design, 2025) | Mourning, death, funerals (China, Japan, Korea); Humility (Insights Psychology, 2025)     | Purity, peace; Authority (e.g., police uniforms) (Alnasuan, 2016)        | Purity, mourning (Sharma & Kapil, 2023)           | High potential for misinterpretation in East Asian markets if used for celebratory contexts. Strong association with minimalism.                  |
| <b>Yellow</b> | Happiness, optimism, warmth, caution (Rocky Mountain College of Art + Design, 2025)             | Sacred, imperial (China); Mourning (Egypt); Courage (Japan) (Insights Psychology, 2025)   | Death, mourning (Mexico, Egypt); Sun, warmth (Insights Psychology, 2025) | Happiness, prosperity                             | Highly variable negative associations (mourning, envy); requires specific local knowledge. Often disliked hue by adults (Rider, 2009).            |
| <b>Green</b>  | Nature, luck, environment, finance, envy, inexperience (Alnasuan, 2016)                         | Health, prosperity, harmony; Infidelity (China); Eternal life (Japan) (Design Dash, 2024) | Nature, vegetation, wealth (Alnasuan, 2016)                              | Holy color (Islam), paradise, fertility, strength | Generally positive (nature, health), but specific negative connotations exist (e.g., Indonesia (Eriksen Translations, 2020). Strong Islamic link. |
| <b>Blue</b>   | Trust, calm, stability, authority, sadness (Rocky Mountain College of Art + Design, 2025)       | Immortality, spirituality, heaven; Femininity                                             | Mourning (Mexico); Trust, tranquility                                    | Protection, spirituality, heaven                  | Relatively safe globally, often signifying trust/calm, but mourning association exists in some                                                    |

|              |                                                                |                                                                     |                                                           |                         |                                                                                                                       |
|--------------|----------------------------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------|-------------------------|-----------------------------------------------------------------------------------------------------------------------|
|              | Mountain College of Art + Design, 2025)                        | (sometimes) (Eriksen Translations, 2020)                            | (Alnasuan, 2016)                                          |                         | specific cultures.                                                                                                    |
| <b>Black</b> | Sophistication, power, elegance, mourning, evil (Cherry, 2024) | Masculinity, knowledge, evil, mourning (Eriksen Translations, 2020) | Masculinity, mourning, religion, respect (Alnasuan, 2016) | Mystery, evil, mourning | Often linked to luxury/power, but strong association with mourning/negativity requires careful context consideration. |

*Note: Associations can vary within regions and are influenced by context.*

● **4.2.3. Individual Differences:** Significant variation exists beyond culture.

○ *Age:* Preferences shift from warm (childhood) to cool (adulthood) (Rider, 2009). Emotional associations also vary (Beins, 2022).

○ *Gender:* Subtle differences exist (Men: stronger blue preference; Women: may favor purple more, be more sensitive to variations) (Rocky Mountain College of Art + Design, 2025). Gender stereotypes influence perception (Liang & Hangeldiyeva, 2024).

○ *Personality:* Potential links exist (e.g., agreeableness/conscientiousness with blue/white preference (Xia et al., 2021), but more research needed.

○ *Personal Experience and Preference:* Unique history strongly shapes individual responses (Rocky Mountain College of Art + Design, 2025). Limits predictability based on general principles.

○ *Physiological Variation:* Differences in color vision (color blindness, cone sensitivities (Haller, 2013) mean individuals perceive color differently, necessitating accessible design (sufficient contrast, not relying solely on color (Editverse, 2024).

These factors limit prescriptive application of broad principles, emphasizing user research, personalization, and accessibility.

**4.2.4. The Impact of Color Combinations, Contrast, and Harmony:** Design involves color interplay (Design Studio UI/UX, 2024).

● *Color Harmony:* Subjective pleasantness/balance from combinations (analogous, complementary (Sanvicente, 2024). Analogous schemes create cohesion; complementary schemes create contrast/energy (Design Studio UI/UX, 2024), potentially enhancing emotion (Zhandyrbay, 2024). Harmony lacks universal definition (Arora & Warsi, 2024). Affective responses seem structured (cool-warm dimension (Park University, 2024).

● *Contrast:* Difference in lightness/hue crucial for hierarchy, readability, accessibility (Iyer,

2023) . Essential for legibility (visual impairments (New Perspective Design, 2023). Draws attention (CTAs) (Iyer, 2023).

- **Saturation and Brightness:** Often stronger influence on emotion (arousal, pleasure) than hue (Rider, 2009). Higher saturation increases arousal; higher brightness increases pleasure (Rider, 2009). Affective impact depends on interaction of these dimensions (Lin, Mottaghi, & Shams, 2024).

Understanding individual hues is insufficient. Designers need holistic consideration of the palette (relationships, contrast, saturation, brightness). Testing specific palettes is crucial.

#### 4.3. Practical Applications and Implications for Design Professionals

Findings imply several practical points:

- **General Principles:** Use color *intentionally* to communicate messages, evoke congruent emotions, guide attention, and enhance user experience (Sanvicente, 2024). Consider audience (age, culture), context, and brand personality (Design Studio UI/UX, 2024). Test choices (A/B testing, user feedback) due to response variability (Rocky Mountain College of Art + Design, 2025).

- **Graphic Design & Branding:** Color is key to brand identity (recognition, personality, loyalty) (Rider, 2009). Consistency across touchpoints is vital (Bytyçi, 2020). *Appropriateness* to brand personality/positioning is often critical (Design Studio UI/UX, 2024). Consider medium differences (print vs. digital (Hecks, 2025).

- **Web & User Interface (UI) Design:** Color impacts UX (engagement, mood, trust, usability, conversions (Sanvicente, 2024) .Use strategically for hierarchy, navigation, CTAs (Design Studio UI/UX, 2024). Blue fosters trust (World Design Council, 2024); red/orange for action (Koch, 2024). Ensure contrast for readability/accessibility (Iyer, 2023). Dark mode interfaces explored (Fialkowski & Schofield, 2024).

- **Interior Design:** Color affects atmosphere, mood, function (Rocky Mountain College of Art + Design, 2024). Warm colors energize; cool colors calm (bedrooms, healthcare (Arora & Warsi, 2024) . Green reduces stress, enhances well-being/creativity (work/learning spaces) . Strategies like 60-30-10 rule create balance. Consider space function, client preference, light, materials (Rocky Mountain College of Art + Design, 2024).

**Product Design:** Color influences perception of attributes, quality, value. Black/white/silver convey luxury/tech. Color differentiates products, influences purchase decisions (Cherry, 2024) .

#### 4.4. Ethical Considerations

Color's subconscious influence (Bytyçi, 2020) raises ethical issues.

- **Manipulation vs. Persuasion:** Fine line between ethical persuasion (guiding attention, enhancing usability) and unethical manipulation (exploiting vulnerabilities, misleading impressions)

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. Transparency is key (Rauten, 2024).

- **Cultural Sensitivity:** Using colors without understanding cultural connotations can cause offense or reinforce stereotypes. Responsibility to research and respect differences (Appear Online, 2025).

- **Accessibility:** Relying solely on color or using insufficient contrast excludes users with visual impairments. Ethical design requires adherence to guidelines (e.g., WCAG) (Iyer, 2023).

- **Informed Application:** Given nascent field/methodological weaknesses, making definitive claims or applying principles without context/limitations is irresponsible. Use findings prudently, acknowledge uncertainty, prioritize user well-being (Elliot, 2015).

#### 4.5. Limitations, Inconsistencies, and Research Gaps

The field faces limitations:

- **Methodological Weaknesses:** Inadequate color specification/control, disregard for viewing conditions, underpowered samples, ecologically limited stimuli (Rider, 2009). Undermines reliability/generalizability.

- **Theoretical Gaps:** Need for *mid-level* theories with predictive precision for specific design domains (Elliot, 2015). Gap between theory and practice remains (Mirzaei, 2025).

**Limited Scope:** Heavy focus on few hues (red, blue), neglect of saturation/brightness interactions (Rider, 2009). Effects of combinations, textures, interactions with other elements underexplored (Rocky Mountain College of Art + Design, 2024).

- **Inconsistent Findings:** Contradictory results (e.g., red's effect on performance; color impact on affective judgments (Aguayo, n.d.) highlight need for research on moderators.

- **Lack of Longitudinal Studies:** Long-term effects of color exposure less understood.

**Generalizability:** Findings from lab settings/student populations need validation in diverse real-world scenarios (Elliot, 2015c).

#### 4.6. Future Research Directions

Addressing limitations suggests future directions:

- **Methodological Rigor:** Prioritize precise color specification (standardized spaces, spectral data), control of viewing conditions, powered samples, validated measures. Promote pre-registration/data archiving (Elliot, 2015).

- **Ecologically Valid Stimuli and Contexts:** Use realistic design stimuli (prototypes, VR (Bonnardel, Piolat, & Bigot, 2010), product designs, renderings) and investigate effects within specific contexts (Park University, 2024).

- **Focus on Moderation and Interaction:** Systematically investigate moderators (culture,

age, personality, task, context (Elliot, 2015) . Examine interactions between hue, saturation, brightness, and other design elements (Rider, 2009).

- **Broader Range of Colors and Outcomes:** Expand investigation beyond primary hues to include neutrals, metallics, etc.. (Elliot, 2015) Explore broader outcomes (creativity, decision strategies, social perceptions, long-term well-being).

- **Cross-Cultural Research:** More rigorous studies using matched stimuli/methods to disentangle universal vs. learned responses (Arora & Warsi, 2024).

**Bridging Theory and Practice:** Develop/test mid-level theories for specific domains (UI/UX, therapeutic environments) (Elliot, 2015). Foster psychologist-designer collaboration.

- **Longitudinal Studies:** Investigate cumulative/long-term effects in real-world settings (Rockfon, 2022).

- **Neuroscience Approaches:** Continue using neuroimaging/psychophysiology to elucidate underlying mechanisms (Sanvicente, 2024).

## 5. CONCLUSION

Color is a psychologically significant design element influencing affect, cognition, and behavior. Research links specific colors (red, blue, green) to distinct responses (arousal, calmness, trust/nature associations). However, color psychology in design is complex and developing. Simple, universal meanings are largely unsupported; impact emerges from dynamic interplay between color properties, context, culture, personal history, and combinations.

The Color-in-Context theory provides a valuable lens, emphasizing situational analysis over prescriptive rules. Methodological rigor remains a challenge, requiring future research to prioritize precise control, ecological validity, powered samples, and investigation of moderators/interactions.

For designers, this review highlights using color thoughtfully and ethically—leveraging its potential while being sensitive to culture, individual differences, accessibility, and manipulation risks. Continued research, especially psychologist-designer collaboration, is needed to refine theory and translate findings into reliable, evidence-based guidelines. Patience and prudence regarding definitive conclusions are warranted until the field matures.

*Acknowledgments:* The authors thank the editors and anonymous reviewers for their constructive feedback.

*Funding:* This study was not supported by internal or external funding sources. All research presented in the article was conducted at the expense of the author(s).

*Data Availability Statement:* All supporting data generated or analyzed for this study are available upon request.

*Ethics Approval and Consent to Participate:* Not applicable.

*Consent for Publication:* Not applicable.

*Competing Interests:* The authors declare that they have no competing interests.

*Additional Notes on Research Methods:* All analyses and findings presented in this article were conducted through the integration of open-source

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materials, utilizing publicly available online resources and artificial intelligence (AI) tools. The authors affirm that AI was used exclusively as a research assistance instrument in compliance with academic integrity standards, and that the interpretation, validation, and final presentation of results remain solely the responsibility of the authors.

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Received: 05/10/2024  
Accepted: 05/03/2025

**Publisher's Note:**

ASPU Publication remains neutral concerning jurisdictional claims in published maps and institutional affiliations.