# The Role of Color in Emotional Responses and Visual Attention in Mobile Interfaces: A Narrative Review

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## ABSTRACT

Color is one of the first things users notice on a screen. However, research on how color affects emotion and attention in mobile interfaces is spread across human computer interaction (HCI), ergonomics, marketing and psychology. This narrative review brings that research together around two outcomes: users' emotional responses and their visual attention. It draws on foundational work in color psychology and visual attention and on peer-reviewed empirical studies, published since 2010, that manipulated color in smartphone, tablet or other small-screen interfaces. Three patterns emerge. First, how color is organized matters more than any single hue. Color that makes items distinct from one another or groups them clearly speeds visual search and is rated as more pleasant, usable and attractive, and lower-saturation backgrounds improve both search time and aesthetic ratings. Second, first attention is drawn by contrast between an element and its surroundings. Warm hues attract more first fixations in icon grids, but hue has no clear effect on search once color is used to group items, and many colors within a single icon tend to slow search. Third, the comfort benefit of dark mode depends on context: it reduced eye fatigue on smartphones in bright but not dim light, and produced no difference in self-reported fatigue on tablets under ordinary indoor lighting. The evidence base has clear limits. Most studies are laboratory experiments with young adults in East Asia and Europe, many simulate mobile screens on other displays, and the influence of age and culture on mobile color effects has hardly been tested; no study reviewed here sampled South Asian users. The review closes with provisional design guidelines and an agenda for research on real handheld devices, physiological measures of emotion and more diverse users.

**Keywords:** Color, Mobile user Interface, Emotional Response, Visual Attention, Narrative Review, Interface Design

## INTRODUCTION

Color is one of the first visual features a user notices on a screen. It affects both how an interface feels and where the eye goes. Early work in color psychology showed that hue, saturation and brightness can change people's feelings of pleasure, arousal and dominance (Valdez & Mehrabian, 1994). Later reviews confirmed that color carries psychological meaning, not only aesthetic value (Elliot & Maier, 2014). Research on perception also shows that color is one of a small number of features that guide visual attention: a colored target can "pop out" from the items around it (Treisman & Gelade, 1980; Wolfe & Horowitz, 2004).

HCI research has applied these ideas to screen design. Studies of websites show that color affects how attractive and trustworthy a site seems and whether users want to return, and that these effects differ between cultures (Bonnardel et al., 2011; Cyr et al., 2010). Users form a first impression of a web page in about 50 milliseconds, before they read any content (Lindgaard et al., 2006), so visual features such as color play a central role in early judgments. Norman (2004) calls this the visceral level of emotional design: a fast, automatic reaction to how something looks. In mobile commerce, perceived design aesthetics have been linked to usefulness, ease of use, enjoyment and, through these, to customer loyalty (Cyr et al., 2006).

Mobile interfaces are used in different conditions from desktop screens. The screens are small and held close to the eyes. People use them in short sessions and interact by touch rather than with a mouse. Ambient light

changes often, and system features such as dark mode and automatic brightness change how colors actually appear. For these reasons, findings about color on desktop websites may not transfer to smartphones. Yet research on color in mobile settings is spread across several disciplines and has rarely been considered as a whole.

This narrative review brings that research together. It addresses three questions:

1. **Q1.** How do color features in mobile interfaces (hue, saturation, brightness, contrast and dark or light mode) affect users' emotional responses?

2. **Q2.** How does color in mobile interfaces guide visual attention, and how does this affect searching for and recognizing interface elements?

3. **Q3.** Which methods and contextual factors (such as ambient light, age and culture) shape these findings, and what gaps remain?

## APPROACH TO THE REVIEW

This is a narrative review rather than a systematic review. Its purpose is to bring together and interpret a dispersed body of research and to identify themes and gaps, not to estimate pooled effects. Relevant literature was identified through searches of Google Scholar and publishers' platforms using combinations of color terms (with both the American spelling "color" and the British spelling "colour"), emotion and attention terms (for example emotion, aesthetic, user experience, eye tracking and visual search) and mobile-interface terms (for example smartphone, tablet, mobile app and app icon). Reference lists of relevant articles were then checked for further studies.

The review gives most weight to peer-reviewed empirical studies, published from 2010 onward, that manipulated color in a mobile or small-screen interface and measured an emotional outcome (such as aesthetic, preference, user-experience or comfort ratings) or an attentional outcome (such as eye-tracking measures or search time). Studies that simulated mobile interfaces on other displays were included but are identified as such. Foundational studies of color psychology, visual attention and web design are used to interpret these findings. Eleven empirical studies form the core of the discussion; they are summarized in Table 1. Because the review is narrative, it does not claim to be exhaustive, and its conclusions should be read as an informed synthesis rather than a quantitative estimate.

**Table 1.** Empirical studies of color in mobile interfaces discussed in this review

| Study | Interface and display | Color variable | Method | Main color finding |
|---|---|---|---|---|
| Baik et al. (2013), South Korea | Smartphone-context 5 × 5 icon array | Hue, tone, color combination | Eye-tracking experiment; 15 college students | Warm hues and complementary contrast drew most attention; tone had no significant effect on initial attention |
| Choi & Suk (2015), South Korea | Icon-matrix interface for smart devices | Hue, tone, foreground–background combination | Eye-tracking experiment | Warm hues and high foreground–background contrast most conspicuous; no clear brightness pattern |
| Trapp & Wienrich (2018), Germany | App-icon screens on touch displays styled as a smartphone | Color similarity of target and distractor icons | Two experiments (18 and 36 participants); search time; user-experience ratings | Distinct target colors sped search and were rated more intuitive, usable and attractive, with more positive emotion |
| Cao et al. (2021), China | Mock mobile web directories | Color salience and location of a | Eye tracking; performance; affective ratings | Salient link color attracted attention, increased sense of control and improved affective |

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|---|---|---|---|---|
| | | link | | ratings |
| Liu, Cao, & Proctor (2021), China | Smartphone app-icon interface | Icon color variety × border shape | Eye tracking; search time; user-experience ratings | Varied icon colors improved search efficiency, reduced cognitive effort and improved user experience |
| Liu, Zhang, & Xia (2021), China | Mobile menu icons | Single-color vs multicolor icon backgrounds and figures | Visual search experiment; reaction time | Line icons on a single-color background were fastest; multicolor icons were slowest |
| Deng et al. (2022), China | App icons on a mobile interface | Background saturation × icon border | Eye tracking; search time; usability and aesthetic ratings | Low-saturation backgrounds gave faster search and higher usability and aesthetic scores |
| Zhang et al. (2022), China | Mobile map navigation icons shown on a 19-inch monitor | Color coding and color grouping | Eye-tracking experiment; 30 students aged 21–29 | Regular color groups sped search and increased satisfaction; randomly mixed colors gave no benefit; specific hue made no difference |
| Perrig et al. (2023), Switzerland | Smartphone web app (online) | Overall visual aesthetics, including color | Online experiment; 281 participants | Better aesthetics raised usability and aesthetic ratings, with some evidence of better performance; color not isolated |
| Pathari et al. (2024) | Smartphone reading (handheld) | Dark vs light mode × dim and bright ambient light | Experiment; self-reported eye fatigue | Dark mode reduced eye fatigue in bright light only |
| Sengsoon & Intaruk (2025), Thailand | Apple iPad, one hour per mode (handheld) | Dark vs light mode under indoor lighting (300–500 lux) | Randomized crossover; 30 women (mean age 21.2); questionnaire and physiological measures | No difference in self-reported fatigue; flicker-frequency and dry-eye measures differed in a direction the authors interpreted as favoring dark mode |

*Note.* Country refers to where the authors are based, where stated in the publication record.

## Color, Emotion and Attention: Theoretical Background

Two lines of theory frame the mobile evidence. The first concerns emotion. Valdez and Mehrabian (1994) showed that brightness and saturation predict feelings of pleasure, arousal and dominance more strongly than hue does. Elliot and Maier (2014) argued that the meaning of a color depends on context, so the same hue can carry different emotional value in different settings. Cross-national research supports this view: color–emotion associations are broadly shared across 30 nations, yet they are also shaped by language and geography (Jonauskaite et al., 2020). Norman's (2004) account of visceral, behavioral and reflective design levels explains why color can shape an emotional reaction before a user has done anything with an interface.

The second line concerns attention. Feature-integration theory (Treisman & Gelade, 1980) and guided-search accounts (Wolfe & Horowitz, 2004) hold that color is processed early and in parallel, so an item that differs in color from its neighbors can be found almost immediately. What matters is the difference between an item and its surroundings, not the color itself. The two lines meet in the "what is beautiful is usable" effect, in which

interfaces judged attractive are also judged easier to use (Tractinsky et al., 2000). The sections that follow examine how far these ideas hold in mobile interfaces.

## Color and Emotional Response in Mobile Interfaces

### Distinct and Well-Organized Color is Rated More Positively

The most consistent finding concerns how color is organized. When a target app icon differed in color from the

icons around it, participants rated the screen as more intuitive, more usable and more visually attractive, and reported more positive emotions (Trapp & Wienrich, 2018). Organizing navigation icons into regular color groups increased satisfaction, ease of use and emotional preference, whereas randomly mixed colors scored no better than a single color (Zhang et al., 2022). Varied colors across app icons led to a more positive user experience (Liu, Cao, & Proctor, 2021), and a link shown in a salient color produced higher affective ratings and a greater sense of control (Cao et al., 2021). Users therefore seem to respond to how color is *organized* on a screen, not only to the colors themselves.

### Softer Backgrounds and Overall Appeal

Saturation also matters. Interface backgrounds with low saturation received higher usability and aesthetic scores than high-saturation backgrounds (Deng et al., 2022), which fits the older finding that saturation shapes emotional response more than hue (Valdez & Mehrabian, 1994). At the level of the whole app, a well-designed version of a smartphone web app received higher usability and aesthetic ratings than a poorly designed version, with some evidence of better task performance (Perrig et al., 2023). Because color was changed together with layout and other features in that study, its separate contribution cannot be estimated.

### Dark Mode and Visual Comfort

Dark mode is often promoted as more comfortable, but the evidence depends on context. On smartphones, dark mode reduced self-reported eye fatigue in bright surroundings but not in dim surroundings (Pathari et al., 2024). On tablets under ordinary indoor lighting, one hour of use increased visual fatigue in both modes, with no difference in self-reported fatigue between them, although critical flicker frequency and dry-eye scores differed in a direction the authors interpreted as favoring dark mode (Sengsoon & Intaruk, 2025). Outside the mobile context, a night-time reading study found that dark mode reduced physiological signs of fatigue while participants still preferred light mode, which the authors attributed to habit (Xie et al., 2021). Taken together, these studies suggest that comfort, physiological strain and stated preference do not always agree, and that ambient light changes which mode is more comfortable.

## Color and Visual Attention in Mobile Interfaces

### Color Speeds Search When it Makes the Target Distinct or Groups The Layout

Search was fastest when the target icon's color differed from the distractors, and the advantage grew when the target was on a second screen (Trapp & Wienrich, 2018). Regular color groups on mobile navigation icons shortened search and reduced the number of fixations and the length of eye movements compared with single-color icons; randomly mixed colors gave no benefit, and red, green and blue groupings performed equally well (Zhang et al., 2022). Varied icon colors improved search efficiency and reduced cognitive effort (Liu, Cao, & Proctor, 2021), and a salient link color attracted attention in a mobile web directory (Cao et al., 2021). These results match guided-search theory: color helps when it creates a difference that the visual system can use (Wolfe & Horowitz, 2004).

### Background Saturation Affects Search Time

Search tasks were completed faster on low-saturation than on high-saturation backgrounds, and the effect interacted with the shape of the icon borders (Deng et al., 2022). A calmer background appears to let foreground elements stand out more clearly.

### Contrast and Warm Hues Attract the First Glance

In smartphone-context icon arrays, warm hues attracted more attention than cool hues, changes in tone did not significantly change initial attention, and icons with complementary color contrast attracted the most attention (Baik et al., 2013). A follow-up study confirmed that warm hues were more eye-catching, that highly saturated colors were most conspicuous against a black background, and that high foreground–background contrast produced the strongest conspicuity, while brightness showed no clear pattern (Choi & Suk, 2015). Hue therefore influences which isolated element is noticed first, but it did not affect search once color was used to group items (Zhang et al., 2022).

### Many Colors Within One Icon Can Slow Search

Color does not help in every form. In mobile menus, line icons on a single-color background were found fastest, and icons with multicolored backgrounds and figures were slowest (Liu, Zhang, & Xia, 2021). Color that separates items helps users, whereas color complexity within an item adds visual clutter.

### Methods and Moderating Factors

**Ambient light** is the moderator with the clearest evidence: it changed whether dark mode reduced fatigue on smartphones (Pathari et al., 2024). **Age** has received little attention in mobile color research. Outside the mobile-specific literature, the cognitive load of dark displays differed between younger and older adults depending on ambient light (Sethi & Ziat, 2023), and an online study of color–emotion associations found that some associations varied with age and gender (Šķilters et al., 2023). Neither study tested a mobile interface, so whether age changes mobile color effects remains an open question. **Culture** is similarly untested in the mobile studies reviewed here, although the appeal of website colors is known to differ between countries (Cyr et al., 2010).

Methodologically, the evidence base is narrow. Most studies were laboratory experiments with students or young adults. Only two studies in Table 1 tested handheld devices in the laboratory (Pathari et al., 2024; Sengsoon & Intaruk, 2025); others ran online or simulated mobile layouts on a monitor or touch display, which their authors acknowledged reduces ecological validity (Zhang et al., 2022). Emotional responses were measured mainly through self-report, physiological measures were rare, and no study followed users over repeated, real-world use. Null results may also be under-represented in the published literature; one mobile-game study that found no effect of hue or saturation on adolescents' emotions was, at the time of writing, available only as a preprint (Kallabis et al., 2024).

## DISCUSSION

### Color Works Through Structure and Contrast More Than Hue

Across the studies reviewed, color helps users when it organizes the interface. Making a target distinct from its neighbors, grouping related items by color and using moderate background saturation improved both search performance and user ratings (Cao et al., 2021; Deng et al., 2022; Liu, Cao, & Proctor, 2021; Trapp & Wienrich, 2018; Zhang et al., 2022). Hue mattered mainly for the first glance at isolated items (Baik et al., 2013; Choi & Suk, 2015). Many colors inside one icon, by contrast, slowed search (Liu, Zhang, & Xia, 2021). The emerging principle is that color should separate items rather than decorate them.

Emotion and attention usually pointed in the same direction: conditions that were easier to search were also rated as more satisfying, attractive and pleasant (Deng et al., 2022; Trapp & Wienrich, 2018; Zhang et al., 2022), much like the "what is beautiful is usable" effect on desktop interfaces (Tractinsky et al., 2000). Display mode is the main exception, since physiological indicators, self-reported comfort and preference did not always agree (Sengsoon & Intaruk, 2025; Xie et al., 2021).

### Why Mobile Context Matters

The mobile findings differ from desktop web research in two ways. First, ambient light changes constantly, and the same color scheme led to different comfort results in bright and dim settings (Pathari et al., 2024); desktop studies rarely test this because office lighting is stable. Second, small screens leave little space to separate elements, so color becomes more important for grouping: when designers cannot add space, they can still use color to create structure. Time may be a third factor. Screen color can change how long a wait feels, with more relaxing colors making loading seem faster on desktop web pages (Gorn et al., 2004). Mobile sessions are short and loading delays common, so this link between color, emotion and perceived time deserves direct testing on mobile devices.

## DESIGN IMPLICATIONS

Four provisional guidelines follow from the evidence. Because the evidence base is small and mostly laboratory based, they should be validated with each product's users:

1. Use color to make important items distinct from their neighbors and to group related elements into a few consistent areas, rather than scattering many colors.

2. Use softer, low-saturation backgrounds, keep strong contrast for the element users must notice first, and avoid many colors within a single icon.

3. Offer both light and dark modes and consider adapting the mode to ambient light, since dark mode is not always more comfortable.

4. Test color schemes with the intended users, because preference, comfort and performance can diverge and the effects of age and culture are not yet established.

### Cultural Context and Under-Represented Users

The studies reviewed here were conducted with participants in East Asia, Europe and Southeast Asia, and none sampled South Asian users, including users in Sri Lanka. Because color–emotion associations are shaped partly by language and geography (Jonauskaite et al., 2020), and website color appeal differs between countries (Cyr et al., 2010), it cannot be assumed that the mobile findings summarized here apply in the same way to South Asian users. Testing them directly with South Asian samples is a clear priority for future research.

## LIMITATIONS OF THIS REVIEW

As a narrative review, this article did not follow a registered protocol or a fully reproducible search, and studies were not screened by independent reviewers or formally appraised for quality. Relevant studies may therefore have been missed, especially those published in Chinese- and Korean-language HCI journals, and the selection of studies may reflect the author's judgment. Within the studies discussed, color was sometimes changed together with other features, such as border shape or overall design, so its separate effect could not always be identified (Deng et al., 2022; Perrig et al., 2023). The conclusions should be tested in a future systematic review as the evidence base grows.

## CONCLUSION

Color affects both how mobile interfaces feel and where users look. In the studies reviewed, these effects came mainly from how color was organized and from contrast, saturation and display mode, rather than from particular hues. Color that made items distinct or grouped them clearly, together with lower background saturation, improved visual search and received more positive ratings; contrast and warm hues attracted first attention; and many colors within one icon tended to slow search. The comfort benefit of dark mode depended on ambient light and on the measure used.

Future research should address four gaps. Studies should (a) test color on real handheld devices, using mobile eye tracking in natural lighting; (b) separate the effect of color from other design features; (c) combine self-report with physiological measures of emotion over repeated, real-world use; and (d) include under-represented groups, especially older adults and South Asian users, to test whether the reported effects generalize. Filling these gaps would give designers evidence-based guidance for the screens people now use most.

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