Visual Congruence in Interface Design:

How Shape and Color Influence Button Clarity Across Task Types

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Abstract

Digital interfaces rely on visual cues to communicate the meaning of interactive elements such as buttons. This study examined how color and shape jointly influence perceived clarity for website buttons, with a focus on situations in which these visual cues either match or mismatch with each other and are congruent or incongruent with the task type. Although extensive research has examined color-emotion associations and cognitive interference effects, such as those demonstrated by the Stroop task, these insights have rarely been applied to interface contexts where multiple visual cues must be interpreted simultaneously. As a result, it remains unclear how users weigh color and shape relative to each other when they convey conflicting signals in interface design, motivating the present study. To address this gap, a 2 × 2 within-subjects experimental design was employed in which 111 participants evaluated the clarity of website buttons varying in visual match (matched vs. mismatched) and task congruency (congruent vs. incongruent). In line with the first hypothesis, visually matched buttons were expected to be perceived as clearer; however, this hypothesis was not supported. In line with the second hypothesis, buttons that were congruent with the task meaning were perceived as significantly clearer than incongruent buttons. An exploratory analysis further showed that when color and shape conflicted, color had a stronger influence on perceived clarity than shape. Qualitative responses supported these findings, with participants frequently referring to color-text alignment and established interface conventions. Together, these results indicate that perceived button clarity is shaped less by visual consistency alone and more by how well visual cues align with task meaning and users' learned expectations. Practical implications for these findings are discussed.

Keywords: perceived clarity, visual match, congruency, interface design

Table of contents

1. Introduction

In today's digital world, many everyday decisions are made online. Shopping, searching for information and communicating all take place through web interfaces, where users are repeatedly required to choose between actions such as clicking, confirming, or deleting. Because these interactions are frequent and can be time-constrained, users tend to rely on quick, intuitive interpretations rather than deliberate analysis (Sutil-Martín & Rienda-Gómez, 2020). Because of this, website design plays a crucial role in how easily people navigate and interact with the digital world. Website design relies mainly on visual elements to communicate meaning and guide user interaction. When users navigate a site, they often depend on simple cues, such as simple color or shape, to decide what actions to take (Zhang et al., 2022). If the meaning of these cues are unclear, users may feel uncertain about what a particular element will do, which can reduce efficiency and trust in the interface (Spiratos & Kořistová, 2021). Research in human-computer interaction has shown that even small changes in design, such as adjusting the size and spacing of buttons in a mobile app, can significantly affect user behavior (Fialkowski & Schofield, 2024; Wright et al., 1997; Xiao et al., 2024).

Among interface elements, buttons play a particularly important role. They act as methods for interaction, allowing users to, for example, complete actions such as submitting input, confirming choices, or canceling an action. Research in human-computer interaction shows that visual design choices can significantly influence how users perceive and engage with these elements. For instance, colored buttons have been associated with increased pleasure, arousal, and trust, as well as reduced cognitive effort, as shown by neuroimaging studies (Nissen et al., 2024). This suggests that even subtle visual enhancements can improve user experience and behavioral outcomes. Previous work has also highlighted that visual aspects of buttons, like color or shape, are not just aesthetic choices but meaningful signals that shape user expectations (Boyd & Bond, 2021). When a user's expectations of a button's function are met, they experience higher perceived clarity, the immediate sense that something, in this case the button's function, is easy to understand.

One heavily studied visual aspects in design is color. Research by Palmer and Schloss (2010), Elliot and Maier (2014), and Teye and Esseku (2023) shows that color not only affects aesthetics but also guides emotion, behaviour, and cognition, allowing users to quickly interpret an element's function based on learned associations. People tend to respond to certain colors in predictable ways, quickly interpreting what an element might do based on experience or associations. For example, brighter or more vivid colors often draw attention, while muted tones are perceived as less urgent (Camgöz, 2000). These associations allow users to make fast and intuitive decisions when navigating interface elements, helping them understand the purpose of buttons (O'Connor, 2013).

Shape is another visual aspect that influences how people interpret design elements. Certain shapes carry strong psychological associations that affect how they are interpreted (Manippa & Tommasi, 2021). For example, angular shapes are often linked with sharpness or danger, whereas round shapes tend to be associated with safety, friendliness, or approachability (Bar & Neta, 2006; Palumbo et al., 2015). In website design, these associations can form our expectations: a rectangular button may be perceived as more formal or task-oriented, while a circular button might feel more inviting (Bar & Neta, 2006). This shows that, like color, shape can also provide users with intuitive cues about the possible function of an interface element (Nissen et al., 2024).

The interaction between color and shape introduces the concept of '*visual match*'. This refers to how well the intuitive signals, conveyed by a button's shape and color, match with each other. Angular shapes are often seen as sharp or commanding, while round shapes feel soft or inviting (Chiu & Chen, 2024). Similarly, red can signal caution or stopping, and green can signal safety (Pravossoudovitch et al., 2014). In this study, the term visual match refers to a button where its shape and color send consistent signals. For example, a red, angular button signals a warning or stop, similar to the red stop signs commonly seen on streets (Meliksetyan, 2025; Palumbo et al., 2015). When these cues conflict, such as a green and angular button, this will be referred to as a visual mismatch in this study and may cause hesitation or confusion because incongruent features

require additional cognitive processing to resolve (Ruzzoli et al., 2020). Research suggests that people process visually matched signals more fluently, making them feel clearer and easier to understand (Spaak et al., 2022).

While button design plays an important role in how users interact with an interface, the context in which a button is used also matters (Cockburn et al., 2020). Buttons are often linked to different types of tasks, which can be positive (such as confirming or saving), negative (such as cancelling or deleting), or even neutral (such as opening information). Negative tasks tend to make users more careful and deliberate, as the way a task is presented has been shown to strongly affect choices through interfaces (Cockburn et al., 2020). This shows that the way a user interacts with a button cannot be understood through design alone but should also be studied alongside the context in which this button has been placed.

When the visual design of a button aligns with its task type (context), the button will be referred to as '*congruent*' in this study. This means that the meaning suggested by a button's visual match matches the type of the task. For example, when a green rounded button, a visual match, is aligned with a positive task, it will be considered congruent. In contrast, when a design does not fully fit the task type, this study will refer to it as '*incongruent*'. For instance, when a green rounded button is used to signal a negative action, it sends mixed signals by appearing friendly and safe for a negative task. Research on predictive processing suggests that incongruent elements may trigger stronger prediction-error responses compared to congruent elements, potentially leading to confusion or slower interpretation (Spaak et al., 2022). In the condition where a button is visually mismatched, where only either the color or the shape aligns with the task, it will also be considered incongruent. These distinctions are essential, as (in)congruency between a button's visual cues and its task can affect how clearly users interpret its purpose.

Perceived clarity refers to how easily and immediately a user can understand the function of a button without needing any additional thought. A button is perceived as clear when its purpose is

obvious, allowing users to interact with confidence. When clarity is low, users may hesitate and question the outcome of a click, which increases cognitive effort and slows interaction (Hsueh & Chen, 2025). Research shows that when visual cues such as color and shape are congruent with the expected meaning, users process the button easier and experience higher clarity. In contrast, incongruent designs disrupt their processing and can make a button feel confusing or misleading (Spaak et al., 2022). Therefore, perceived clarity is shaped by both the visual match of a button's design, and the congruence between this visual match and the task type.

Despite of the fact that shape and color have been studied a lot as separate concepts, there is insufficient research on how they work together (Bar & Neta, 2006; Camgöz, 2000). Most existing studies overlook how people actually process design elements as a combination rather than in parts. Previous work has also not explored how the effect of this visual match may depend on the type of the task. Ignoring task type leaves a gap in understanding how users interpret interface elements in realistic settings. This study addresses this gap by examining how the congruency of visual match and task type interact with each other and how it affects the perceived clarity. The findings can support interface designers in creating clearer and more intuitive button designs that reduce cognitive effort to understand. Therefore, the research question is: "*Does the visual match (shape - color) of a website button affect users' perceived clarity, and to what extent does this effect differ across congruent and incongruent (visual match - task type) combinations?*".

Studying how visual match and task congruence affect perceived clarity can help in our understanding of how users process visual cues and how they make their decisions based on it. While previous research has examined color and shape separately, this study treats them as a combination and examines how the context of the text (text type) affects their interpretation. This not only contributes to theories of cognition in human-computer interaction (HCI) but also offers insights for interface design, helping designers create buttons that reduce user hesitation and support faster decision-making. Importantly, unclear or misleading button designs are not only

inefficient but can also be harmful, for example when visual cues conflict with task meaning, users may be nudged into unintended actions, a practice that is increasingly associated with so-called "dark patterns" (Mathur et al., 2019). Buttons that are immediately understandable can therefore prevent mistakes, improve efficiency, and make interactions with digital interfaces smoother, more comfortable, and more transparent to use (Korala, 2024).

2. Theoretical Framework

This theoretical framework explains how visual cues and task meaning interact to influence the perceived clarity of website buttons. Perceived clarity refers to the ease with which users can understand a button's function without deliberate reasoning. Aligned visual cues, such as color and shape, help users interpret interface elements more quickly and accurately, whereas conflicting cues can slow interpretation and create uncertainty (Saarela & Landy, 2012; Nummenmaa & Hietanen, 2009). This framework therefore focuses on how congruence between color, shape, and task meaning affects perceived clarity in button design.

2.1 Visual match and perceived clarity

Visual cues play a central role in how users interpret website buttons. Before reading any text, users have already seen the button's appearance. This section explains how color and shape function as affective signals and how their combination could influence perceived clarity.

2.1.1 Color and its emotional value

The visual system operates with high speed, with the brain able to categorize complex images in roughly 150 milliseconds (Thorpe et al., 1996). Following this, Railo et al. (2011) demonstrated that chromatic processing, the brain's processing of color, occurs as soon as 70-100 milliseconds after the stimulus. Their experiments suggest that color information can influence

behaviour even when participants are unaware of seeing the color, suggesting that colors are processed automatically and without conscious thought. These findings show that color is extracted extremely quickly and can guide perception and behaviour long before conscious recognition takes place.

This automatic processing could be a reason why people tend to associate specific colors with particular emotions (Clarke & Costall, 2008; Wexner, 1954). For example, red frequently signals danger, high arousal, or strong emotions like passion and anger, while green and blue are linked to calmness, safety, and more positive, low-arousal emotions (Clarke & Costall, 2008; Wexner, 1954). Opponent-Process Theory explains part of this pattern by proposing that human color perception is organized into three neural pairs: red-green, yellow-blue, and black-white, where activation of one color suppresses its opponent (Jing, 2024). This neural organization may strengthen the emotional contrast between red and green, which are often used to signal negative versus positive actions in interfaces.

Such associations are also learnt through repeated exposure in everyday life. One example of this learnt association is based on achievement situations where red often means failure, as bad answers are generally marked with red (Elliot & Maier, 2012). This carries over to digital platforms such as Word, where incorrect words are also marked with a strong red hue. This contrast has prompted other researchers to study the specific meanings of both red and green and what they imply for user behaviour (Bouhassoun et al., 2022).

A systematic review by Jonauskaite and Mohr (2025) analyzed 132 studies from 64 countries examining how people associate colors with emotions. Participants completed tasks matching colors to emotional terms such as happiness, anger, or sadness. The results showed highly consistent patterns: light and warm colors like yellow and orange were associated with positive, high-arousal emotions, cool colors like blue and green with positive, low-arousal emotions, and dark colors like grey and black with negative emotions. Red stood out as being strongly linked to high-arousal

emotions of both positive and negative valence. This review demonstrates that color-emotion associations are systematic and cross-cultural.

Other studies confirm and extend these patterns. Clarke and Costall (2008) reported that most participants described red as highly emotive, often connecting it to anger, passion, or love. Earlier research by Wexner (1954) showed that red is more likely to be associated with exciting or stimulating emotions, blue with feelings of security or comfort, and yellow with cheerfulness. Across age groups, these color-emotion associations remain stable, though older adults tend to show fewer but more intense links to colors (Jonauskaite et al., 2023). Together, these findings indicate that color automatically conveys meaningful emotions that shape how clear a user perceives a button to be.

2.1.2 Shape and its emotional value

Shape, like color, carries emotional meaning that influences how users interpret visual elements. People generally prefer objects with curved contours over those with sharp, angular features because sharp shapes implicitly convey a sense of threat (Bar & Neta, 2006). These associations arise from both biological sensitivities and learned experiences: sharp forms in the physical environment often signal danger, while round forms are less likely to be harmful. As a result, shape can provide users with intuitive cues about safety or risk, contributing to the clarity of interface elements (Palumbo et al., 2015).

The Bouba-Kiki effect provides strong evidence for these automatic shape-meaning associations (Peiffer-Smadja & Cohen, 2018). In this phenomenon, participants consistently match rounded shapes with soft, “friendly” sounds like “bouba” and angular shapes with sharp, “edgy” sounds like “kiki”. This effect is robust across languages and cultures, suggesting that people have an inherent tendency to interpret shapes in terms of affective qualities (Ćwiek et al., 2022). However, a study by Vainio et al. (2025) found that the Bouba-Kiki effect is not driven by emotional mediation at the implicit level, but still found that shapes themselves are processed emotionally: angular forms

evoke anger, and rounded forms evoke happiness or calmness. This distinction highlights that emotional meaning is an inherent property of shape, not merely a by-product of sound-shape matching.

Because angular and curved forms evoke distinct emotional reactions even at implicit levels, subsequent research has examined how these affective responses translate into preferences and approach behaviours. A study by Palumbo et al. (2015) investigated why people generally prefer smoothly curved shapes by examining how curved and angular polygons are associated with emotional meaning. The results showed that curved shapes were implicitly linked to safety, while angular shapes were linked to danger. In a second experiment, only curved shapes elicited automatic approach reactions, suggesting that curvature has an intrinsic affective appeal beyond merely avoiding threat. The authors conclude that people's preference for curvature reflects both a genuine aesthetic attraction to curved forms and secondary associative processes related to safety, indicating that curved contours possess inherent emotional value.

Therefore, these shape associations could also be relevant in digital environments, where users apply the same intuitions when interacting with interfaces. Research has shown that curved interface designs consistently evoke more positive emotional responses and that curvature has a stronger influence on perception than proportion (Deng, 2022). Together with color, shape forms a critical part of the affective information that guides users' expectations and decision-making in interface design.

2.1.3 Visual match between color and shape

When the emotional meanings of color and shape are consistent, such as a red angular button or a green circular one, the combined signal reinforces a single interpretation. In contrast, a green angular button or a red circular button sends mixed signals, which can disrupt the user's intuitive understanding (Kang et al., 2022). Because both color and shape carry strong affective

value, mismatches between them may create uncertainty about the intended function of the button, reducing perceived clarity even before the text label is processed.

Color and shape do not operate independently, but interact with each other to enhance cognition (Jin et al., 2022). When multiple visual features point in the same emotional direction, users can integrate these cues more easily, leading to clearer and faster interpretation (Saarela & Landy, 2012). Research on visual cue integration shows that aligned cues improve performance, whereas conflicting cues slow users down and create interference during perception (Nummenmaa & Hietanen, 2009). This suggests that users do not process color and shape separately, but merge them into a single affective impression.

In digital interfaces, the way color and shape interact can directly influence how quickly users locate and identify specific elements on the page, such as buttons, since certain shapes and color combinations reliably speed up visual search performance (Huang & Chiu, 2007). Conversely, mismatched combinations may introduce hesitation or confusion, as users struggle to reconcile conflicting cues. In practice, even subtle mismatches between a button's appearance and its intended action could reduce perceived clarity, highlighting the importance of integrated visual design in web and app interfaces.

Therefore, a visual match between color and shape is expected to support clearer interpretation of buttons, independent of task meaning. When both cues communicate the same emotional tone, users can rely on a unified affective signal, whereas mismatched cues might require additional cognitive effort to resolve the conflict. This leads to the first hypothesis:

H1: Buttons with a visually matched color-shape combination will be perceived as clearer than buttons with a visually mismatched combination.

2.2 Visual match and task congruency

While matching color and shape can support clarity, buttons rarely rely on the design alone. Users also rely on any contributing text or icon that may describe what an action will do, and specifically the text carries its own emotional weight. Certain words can have a negative connotation, such as the word “sadness”, while other words can have a positive connotation such as “amusement” (Barrett, 2004). In other words, certain words can have a positive or a negative association which is important to take into account together with the visual features.

2.2.1 Processing Fluency Theory and the Stroop task

Processing Fluency Theory proposes that people rely on the ease with which information is processed as an internal cue for evaluation (Reber et al., 2004). When stimuli are easy to process, they are more likely to be judged as clear, familiar, and trustworthy. In contrast, when processing is disrupted, people experience uncertainty and reduced confidence in their interpretation. In interface design, this means that when visual cues such as color and shape support the meaning of a task, users can quickly form expectations and act with greater certainty. When these cues conflict, however, users must invest additional cognitive effort to resolve the mismatch, which may lower perceived clarity.

This mechanism is classically demonstrated in the Stroop effect. The paradigm most commonly associated with color-word association and interference is called the Stroop Effect. It shows that when a word’s print color conflicts with its meaning, this mismatch creates information conflict that disrupts performance on tasks requiring cognitive control (Keha et al., 2025). In classic Stroop tasks, participants are slower and make more errors when the color of a word contradicts its meaning, demonstrating that conflicting information reduces processing fluency and creates cognitive interference (Smith et al., 2022; Stroop, 1935). In interface contexts, this disruption is likely to be experienced as lower perceived clarity of a button’s function.

Building on the classic Stroop effect, researchers have shown that emotional meaning can interfere with task performance in the Emotional Stroop task. In this paradigm, participants are instructed to name the ink color of emotionally charged words (e.g., danger, accident, hope) while ignoring their semantic content. Wielgopolan et al. (2025) found that participants were slower and made more errors when naming the color of emotionally salient words compared to neutral ones, indicating that emotional meaning automatically captures attention and disrupts processing fluency. Importantly, this interference pattern was observed both in laboratory and online settings, suggesting that affective interference is robust and not dependent on the experimental environment. These findings demonstrate that emotionally meaningful cues can hinder efficient processing even when they are irrelevant to the task, supporting the idea that affective signals in interface elements may similarly interfere with users' interpretation and perceived clarity of buttons.

Applied to button design, this suggests that users may experience reduced clarity when a button's color-shape combination does not match the emotional tone of the label (text). Even if the label clearly describes the function, incongruent visual cues may slow interpretation or reduce confidence in the intended action. Visual mismatch can therefore undermine perceived clarity by introducing affective interference.

2.2.2 Visual congruency in interface design

Research on the aesthetic-usability effect shows that visual appearance strongly shapes how usable an interface is perceived to be (Kurosu & Kashimura, 1995). When color, shape, and task meaning reinforce each other, users can process information more fluently and are more likely to judge the interface as clear and trustworthy. Conversely, when these elements conflict, users must resolve competing signals, which increases cognitive effort and lowers perceived clarity. This implies that visually matched buttons should be perceived as clearest when they are also congruent with the emotional meaning of the task. When visual match conflicts with task meaning, visual cues and labels may compete, which may reduce perceived clarity. This leads to the second hypothesis:

H2: Buttons that are congruent with the task type will be perceived as clearer than buttons that are incongruent with the task type.

2.3 Relative influence of color and shape

As seen previously in this theoretical framework, color and shape have both been shown to convey emotional meaning, yet they are rarely compared directly within the same context. There is a lot of empirical work on the relationship between color and emotion, many covered in this semantic review by Meliksetyan (2025), whereas the emotional meaning of shape has received far less systematic attention. This imbalance may imply that color is considered a more fundamental or reliable carrier of affective information, but this assumption has rarely been tested directly (Buetti et al., 2019). Because most studies still examine either color or shape in isolation, it remains unclear which cue dominates when their meanings conflict. Since users perceive multiple visual cues simultaneously, situations in which color and shape point in opposite emotional directions provide a unique opportunity to examine their relative influence on perceived clarity.

When a button combines a positive color with a negative shape or vice versa, users are confronted with competing affective signals. In these cases, users must rely more heavily on one feature to resolve the ambiguity. Understanding whether color or shape has a stronger effect in such mismatched conditions is important for interface design, as it can reveal which feature designers should prioritise when visual consistency cannot be fully achieved.

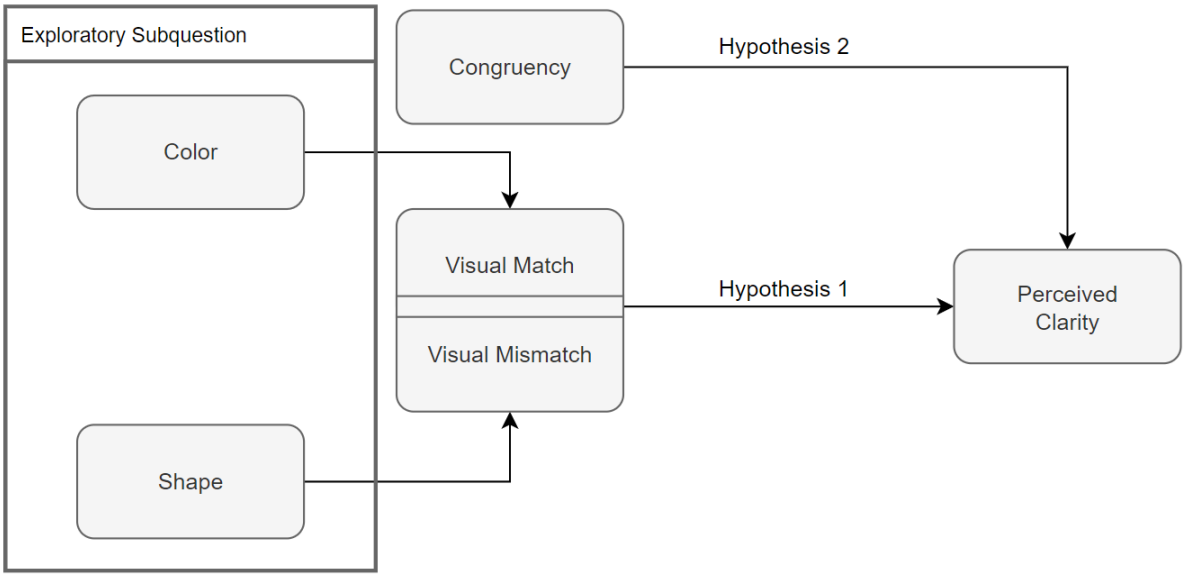
Therefore, this study includes an exploratory subquestion (ES) to examine the relative strength of these cues:

ES: Which feature, color or shape, has a stronger effect on perceived clarity when visual cues are incongruent?

Based on the literature discussed above, a conceptual model was developed to summarize the relationships between visual match, congruency, and perceived clarity. The model, shown in Figure 1, illustrates these relationships, forming the basis for the tested hypotheses. Together, the model provides a structured overview of how the experimental conditions are theoretically expected to influence perceived clarity.

Figure 1

Model of hypotheses (+ exploratory subquestion)



3. Method

3.1 Study design

This study employs a 2 × 2 within-subjects design. The independent variables for the main research question are visual match (visually matched, visually mismatched) and task type (positive, negative) of a button on a web interface. As defined in the introduction, visual match refers to the case where a button's color and shape convey the same meaning. For example, a red button with sharp corners is considered visually matched since they are both associated with a negative task

type (Chiu & Chen, 2024; Pravossoudovitch et al., 2014). When this visual match is aligned with the task type it will be considered congruent, and when the visual match is misaligned with the task type it will be considered incongruent.

The dependent variable is perceived clarity of the button, reflecting how easily participants understand the button's intended function. This captures participants' immediate opinions about how understandable each button is. By analyzing perceived clarity across visual match and task type, the study can determine whether visually matched buttons are generally easier to interpret, and whether alignment with task type further enhances this perceived clarity.

3.2 Participants

A total of 123 participants took part in the study. After removing unfinished responses, a total of 111 participants remained. The mean age was 31.4 years (*SD* = 13.7). The study included 44 males and 67 females. No other demographics were collected. Participants were mainly recruited using convenience sampling, however also survey platforms, specifically SurveyCircle and SurveySwap, were utilized where credits can be earned by filling in other surveys and are spent when others take your survey. The criteria for participating in the study was for the participants to be at least 18 years old and to not be colorblind, as this would result in an inaccurate effect of the manipulations on the participant.

3.3 Materials

The stimuli for this study consisted of eight button images, representing all combinations of the experimental conditions (Two colors x two shapes x two task types = eight unique conditions).

3.3.1 Visual Match

Since each color and shape must be matched with a positive or negative task type, there were two colors and two shapes. The colors were either red (negative) or green (positive) and the shape of the button was either angular (negative) or circular (positive), as both these colors and shapes had shown to carry commonly recognized positive or negative associations and were supported by previous research, as can be further investigated in the theoretical framework (Chiu & Chen, 2024; Pravossoudovitch et al., 2014). Therefore, if both the color and shape had negative associations, they would convey the same meaning and would be visually matched with each other.

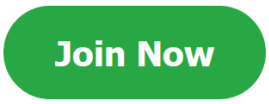
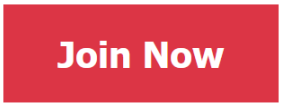
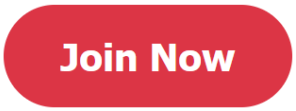
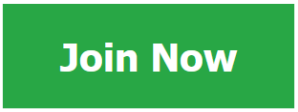
3.3.2 Task Type

The buttons were paired with short task descriptions that reflected either positive or negative actions. A list of button texts was analyzed using a sentiment scoring tool, which uses generic models trained on real user's comments and opinions (text2data.com). The button labels used in the sentiment analysis were selected by the researcher and were intended to represent common actions found in digital interfaces. These phrases were selected because they are short, action-oriented, and typical of button text in everyday web and app interfaces, since the goal was to include clear and intuitive examples that would plausibly appear on real buttons. After inputting a button label, the sentiment analysis would return a score between 1 and -1.

According to this analysis, labels with sentiment scores above +0.5 were classified as positive, while those scoring below -0.5 were classified as negative. Based on the highest and lowest scores, four positive and four negative tasks were selected. This method ensured that the selected tasks were all different from each other and it wouldn’t feel repetitious, while remaining clearly distinguishable in emotional tone. These tasks can be seen in Appendix A, where all four highest and all four lowest scores were used since these met the sentiment score criteria.

3.3.3 Manipulation

Congruency was manipulated by aligning or misaligning the button's visual match with the task type. For example, a congruent button is a green circular button representing a positive action (Figure 2), whereas an incongruent button is a red angular button with an positive action (Figure 3). Lastly the button can be visually mismatched when the shape and color do not match their associated meanings (Figure 4; Figure 5).

Figure 2	***Figure 3***	***Figure 4***	***Figure 5***
Congruent	*Incongruent*	*Visual mismatch (Color)*	*Visual mismatch (Shape)*
			

3.4 Measures

The dependent variable in this study is perceived clarity, defined as how easily participants understand the intended function of each button. Perceived clarity was measured with 1 item using a 7-point Likert scale, with 1 indicating "extremely unclear" and 7 indicating "extremely clear." This scale was created specifically for this study and is not based on an existing standardized measure, as no suitable pre-existing scale was available for assessing the clarity of individual website buttons. A single-item measure was used because perceived clarity is a concrete, specific, and easily understood construct in this context (Fisher et al., 2015). Participants were asked to evaluate the clarity of individual buttons directly after viewing them, making a single rating sufficient to capture their immediate judgment.

Following this, two open questions asked the participants to elaborate on what led them to their decisions. These questions could be used to try and explain unexpected results while giving vulnerable insight into what exactly certain choices were based on. A analysis of the qualitative data is included in the results. The questions were:

How clear or unclear did the buttons feel to you personally, and what aspects of the design influenced your impression?

In your opinion, what makes a button easy to understand or use?

3.5 Procedures

The study was conducted using Qualtrics. Participants were recruited online using convenience sampling. After providing informed consent, participants reported basic demographic information, including age, gender and if they were colorblind.

Participants were presented with the eight button images one by one in a randomized order. Each participant viewed all 8 buttons, and the intended function of the button was provided alongside the image (e.g., “The following button will subscribe you to the newsletter”). Each button has a predetermined, but different description to assure that the participants need to re-evaluate again for each new button. The participants were asked to rate the perceived clarity for each button immediately after seeing the button. Following this, the participants were asked the two open ended questions. At the end, the participants were debriefed and thanked for their participation. The full survey can be found in Appendix B

3.6 Analysis plan

Perceived clarity will be analyzed using Jamovi and a paired samples T-Test will be conducted. This analysis will allow comparison of the means of visual match and visual mismatch, congruency and incongruency and both color and shape conditions on perceived clarity. Assumptions of normality will be checked to make sure the results will be reliable. Also, throughout the open-ended questions, a count will be held to see if either color or shape was mentioned more often as this could lead to interesting insights showing what actually led to peoples decisions.

4. Results

To test the effects of visual features on perceived button clarity, paired-samples t-tests were conducted. These tests allowed comparisons between conditions within the same participants, examining how clarity ratings changed depending on visual match, task congruency, and the relative alignment of color and shape.

4.1 Assumption checks

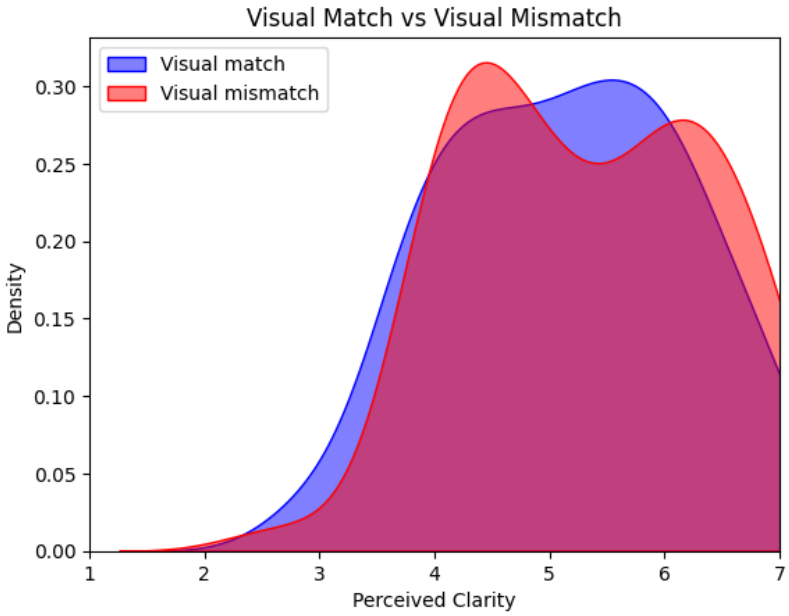
Before testing the hypotheses, the assumptions for paired-samples t-tests were examined. Difference scores for all conditions were assessed for normality using z-scores for skewness and kurtosis. For H1, skewness was 0.93 and kurtosis 1.13, indicating an normal distribution. For H2, skewness was −2.18 and kurtosis −0.72, showing a slight violation of skewness but acceptable kurtosis for parametric testing so normality was still assumed. For the exploratory subquestion, skewness was 0.15 and kurtosis −1.73, confirming normality. Note that the assumption of homogeneity is not relevant for a paired-samples t-test. Because the analysis is based on the difference between paired scores, only a single variance is considered.

4.2 Main analyses

To examine whether visually matched buttons were perceived as clearer than visually mismatched buttons, a paired-samples *t*-test was conducted. First, the average score for both the visually matched and mismatched conditions were calculated, with which the analysis was conducted. On average, visually matched buttons were rated slightly lower in clarity (M = 5.13, SD = 1.04) than visually mismatched buttons (M = 5.27, SD = 1.06). However, this difference was not statistically significant, $t(110) = -1.93$, $p = .056$, 95% CI [−0.30, 0.01], and represents a small effect size, $d = 0.183$. These results suggest that, contrary to the hypothesis, visual matching between color and shape did not enhance perceived clarity in this sample. The density plots in Figure 6 illustrate the comparison between matched and mismatched conditions, showing how they were both quite equally distributed.

Figure 6

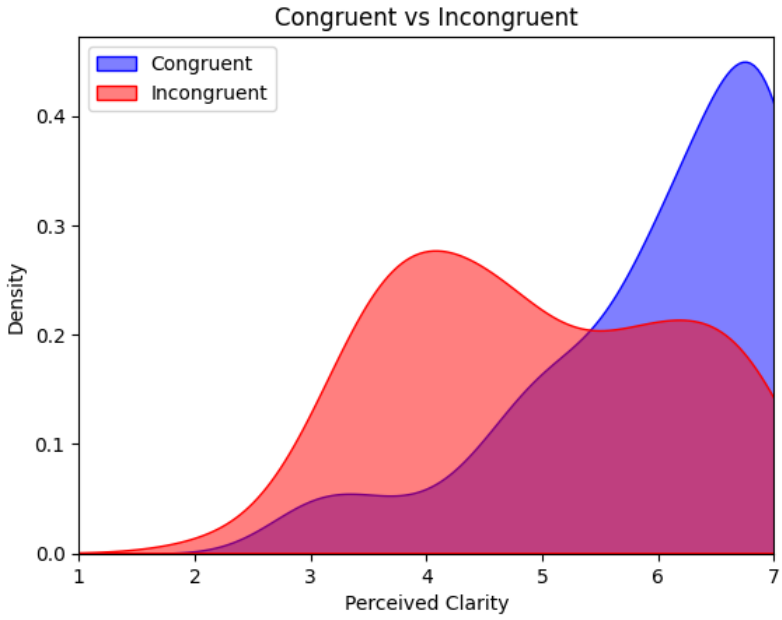
Density plot comparing visual match with visual mismatch.



To assess whether visually matched buttons that were congruent with the task type were perceived as clearer than incongruent buttons (H2), a paired-samples *t*-test was performed. First, the average score for both the congruent and incongruent conditions were calculated, with which the analysis was conducted. Congruent buttons were rated higher in perceived clarity (M = 6.00, SD = 1.08) than incongruent buttons (M = 4.94, SD = 1.23). This difference was statistically significant, $t(110) = 6.95$, $p < .001$, 95% CI [0.78, 1.34], and represents a medium-to-large effect size (d = 0.66). Figure 7 shows the density plots for congruent and incongruent conditions, where it is clearly visible that while the incongruent results are quite spread out, the congruent results are more focussed on the upper end of the scale.

Figure 7

Density plot comparing congruency with incongruency.

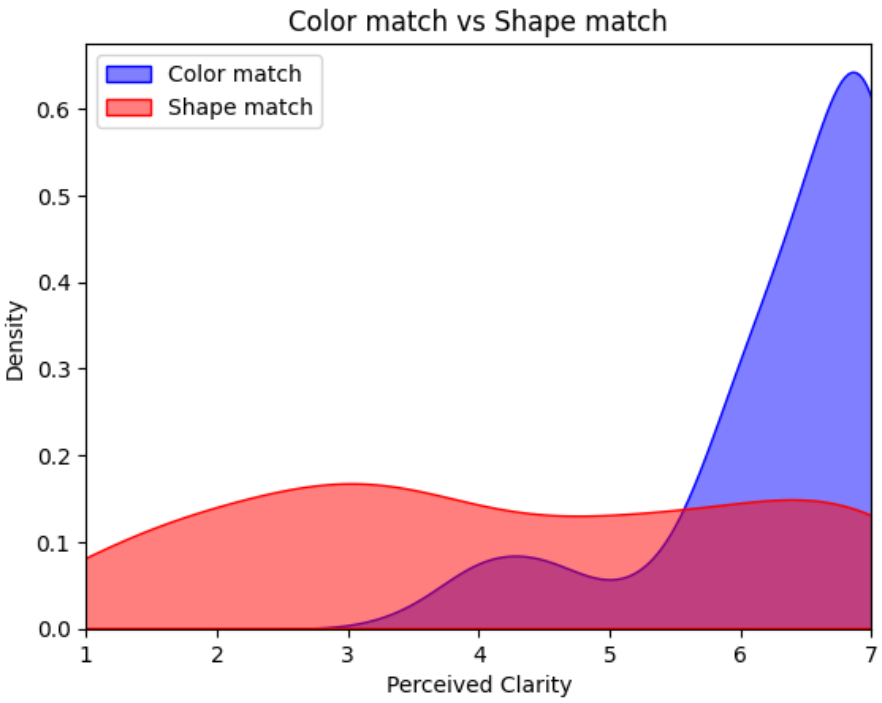


To investigate whether color or shape has a stronger influence on perceived clarity when visual cues conflict (ES), a paired-samples *t*-test was conducted. First, the average scores of the

visually mismatched conditions were calculated, separately for the conditions where only the shape was mismatched and where only the color was mismatched. These average scores were used for the analysis. Clarity ratings were higher when the color matched the expected emotional meaning but the shape did not (M = 6.34, SD = 0.87) than when the shape matched but the color did not (M = 4.21, SD = 1.95). This difference was statistically significant, $t(110) = -10.5$, $p < .001$, 95% CI [−2.55, −1.71], and represents a large effect size (d = 0.993). Open-ended responses corroborate this finding, with color mentioned 74 times compared to 6 mentions of shape. Figure 8 displays the density plots for the color-match and shape-match conditions, clearly showing that the results from the condition where the color was matched to the task were very clear and the clarity for the condition where the shape was matched to the task was very spread out.

Figure 8

Density plot comparing color matches with shape matches.



4.3 Qualitative analysis

The open-ended responses provide additional insight into how participants evaluated the clarity of the buttons and what aspects of the design guided their judgments. Several participants explicitly referred to the importance of aligning color with the emotional meaning of the action. One 23 year old male noted that clarity "*mainly came from the text within the button*" but added that when a "*typically 'negative' action is marked green, for example deleting your account, it does come over somewhat confusing*" This illustrates how mismatches between color and task meaning can undermine clarity even when the label itself is clear. Other participants described more general expectations, such as a 24-year-old female who stated that a button is easy to understand when "*it aligns with text and color expectations*" and a another who explained on the question about what makes a button easy to understand:

"*When the color matches the text. So green for accept, red to reject.*" (25, female)

These responses suggest that participants actively relied on learned color conventions when interpreting button functions.

In addition to color, some respondents commented on the affective meaning of shape. A participant remarked:

"*I liked the buttons with rounded edges more weirdly, I don't know if that makes sense*" (27, female)

indicating an intuitive preference for curvature even without being able to articulate a clear reason. Similarly, a 59-year-old female described rounded buttons as "*nicer*" whereas rectangular ones felt "*more imposing*" Although shape was mentioned much less frequently than color, these comments show that shape contributed to the emotional impression of the buttons. Taken together, the qualitative data support the quantitative findings by showing that participants primarily relied on color-text congruency for clarity, while shape played a secondary but still affective role in shaping how buttons were experienced.

5. Discussion

This study examined how the visual match between color and shape, and their congruency with task meaning, influence the perceived clarity of website buttons. Understanding these effects is important because users often rely on visual cues to decide which actions to take, and unclear buttons can directly lead to mistakes or hesitation.

5.1 Summary of main findings

The first hypothesis was not supported. The analysis did not show a statistically significant effect of visual match on perceived clarity. Although visually mismatched buttons were rated slightly clearer than visually matched ones, this difference did not reach significance. This indicates that internal consistency between color and shape alone does not automatically improve how clearly users understand a button's function.

The second hypothesis was supported. Visually matched buttons were perceived as significantly clearer when their appearance was congruent with the emotional meaning of the task. This shows that clarity is strongly influenced by whether visual cues reinforce the intended action rather than merely matching each other.

Finally, an exploratory subquestion was conducted to examine which visual feature dominates when color and shape conflict, since existing research has largely studied these cues in isolation and provides little insight into how users weigh specific design elements in which their emotional meanings contradict each other. Understanding this is important for interface design, as real-world buttons do not always allow for full visual consistency, potentially prompting designers to choose between certain visual elements. The results showed that color had a substantially stronger effect on perceived clarity than shape: buttons in which color matched the task meaning were rated

much clearer than those in which only shape matched. This indicates that users rely primarily on color rather than shape when resolving conflicting visual signals.

Together, the results of the first and second hypotheses show that visual match between color and shape is not enough by itself to improve perceived clarity. In fact, visually mismatched buttons were rated as slightly clearer than visually matched ones, which directly contradicts the initial expectation. This suggests that users do not simply rely on whether color and shape "fit together" on a visual or affective level. Instead, they appear to interpret buttons primarily through the meaning these cues carry within a specific task context.

Color in Context Theory (Elliot & Maier, 2014) offers an important explanation for this pattern. According to this theory, the meaning of a color is not fixed but depends on the situation in which it appears. Red, for example, may signal danger or failure in achievement contexts, but attraction in romantic ones. In the present study, visually matched combinations such as a red angular button intended for a positive task likely generated conflicting signals: although color and shape were affectively aligned, their combined meaning contradicted the expected function of the button. This conflict may have reduced clarity rather than enhancing it, explaining why visual match alone did not lead to better performance.

The second hypothesis further clarifies this mechanism. When visually matched buttons were also congruent with the task meaning, they were perceived as significantly clearer than incongruent ones. This shows that task congruency can compensate for the limitations of visual match. Users do not evaluate color and shape in isolation but interpret them in relation to what the button is supposed to do. Only when visual cues reinforce the intended action do they support clarity.

Design conventions likely play an additional role in this process. Rounded buttons have been the dominant standard in interface design since early systems such as the Macintosh, which introduced softer shapes to make digital environments feel more approachable (Bryant, 2024). This

long-term exposure may have trained users to associate rounded shapes with safe or positive actions, regardless of whether they are theoretically "matched" with a certain color. As a result, users may prioritize familiar conventions and contextual meaning over pure visual alignment.

Taken together, these findings demonstrate that perceived clarity in button design is shaped by the interaction between color, shape, task meaning, and learned interface conventions. Visual match alone is insufficient; it becomes effective only when it is embedded in a meaningful and contextually appropriate design.

5.2 Exploratory subquestion

The exploratory subquestion examined which visual feature, color or shape, had a stronger influence on perceived clarity when they conflict with each other. This result suggests that participants tend to perceive buttons as clearer when the color aligns with the task, even if the shape did not, compared to when only the shape aligns. This indicates that color may have a stronger effect than shape on clarity judgments, although individual differences likely play a role. One participant illustrated this tendency:

"*In my opinion, a button is easier to understand when it has a fitting color, like green for an 'accept' button or red for a 'decline' button. Also the text, to make sure what the button does. And maybe for a small part, the shape of the button. Most buttons are rectangle shape, so you understand that it is a button. When it is for example the shape of a star or something, it is less clear that it is a button.*" (24, female).

One likely explanation for this effect is that color has a more established role in guiding human perception and affective responses than shape. Several well-known frameworks, such as Color-in-Context Theory by Elliot & Maier (2014) and research on Stroop tasks, highlight how color automatically captures attention, influences cognition, and carries context-specific emotional

meaning. In contrast, although shape does convey affective associations, there are far fewer formalized theories explaining how shape influences perception and behaviour in interface contexts. This imbalance may make color a more salient and reliable cue for users when judging button clarity, even when shape is theoretically aligned with the task.

5.3 Theoretical implications

The findings of this study have several theoretical implications for understanding how visual features interact to guide perceived clarity. First, the results show that visual match by itself is not sufficient to enhance clarity. While color-shape alignment can provide a coherent affective signal, it supports clarity only when it is congruent with the task's meaning. This indicates that cross-modal congruence, such as in the Bouba-Kiki effect linking shape and sound, is helpful but not sufficient on its own. Thus, visual signals require a meaningful context to be fully interpretable and usable, tying in to the following implication.

Second, the study highlights the role of processing fluency in interface design. When visual features and task meaning are congruent, users can interpret buttons more quickly and easily, suggesting that congruent design improves the efficiency of cognitive processing. This extends prior research on fluency in perception and judgment, showing that these principles apply not only to isolated stimuli but also to interactive digital environments.

Finally, the exploratory subquestion demonstrates that color dominates shape when cues conflict. Participants relied more on color than shape to judge button clarity, possibly due to the early perceptual salience of color and its strong, learned affective associations (Railo et al., 2011). While shape conveys affective meaning, it appears less influential in guiding user interpretation in interfaces. This insight provides novel empirical support, as previous research has rarely studied or directly confirmed the relative influence of color and shape on perceived clarity in digital contexts.

5.4 Practical implications for interface design

The results offer clear guidance for interface designers regarding the use of color and shape in buttons. Firstly, color should be prioritized over shape when communicating a button's function. When visual cues conflict, users rely more on color than on shape to interpret the intended action. This means that critical actions, such as "delete" or "confirm," should use colors that match their conventional meanings, such as red for negative or destructive actions and green for positive or affirmative actions, to maximize clarity and reduce misinterpretation.

Secondly, visual match between color and shape is supportive but not sufficient. While combinations like rounded-green or angular-red can reinforce clarity, the effectiveness of visual match depends on whether the appearance aligns with the button's function. Designers should ensure that the meaning conveyed by color and shape is consistent with the task, and that this consistency is maintained across the interface. This approach leverages both the affective signals of shape and the dominant influence of color to create intuitive, easy-to-understand buttons.

5.5 Limitations and future research

This study has several limitations that should be considered when interpreting the results, and each limitation points to directions for future research. Firstly, participants were recruited via convenience sampling, which may not represent the broader population. Factors such as age, cultural background, or digital experience could still influence how visual cues are interpreted. Future studies could try to include more diverse participant samples to examine whether the observed patterns, such as the dominance of color over shape, generalize across different user groups. A difference might occur following the general conventions for button design which older participants or people from countries with less developed online infrastructure might not be as familiar with.

Secondly, only eight button designs were tested, limiting the range of color-shape combinations and potentially restricting generalizability. Real-world interfaces often include more complex combinations of visual features and context, often accompanying a certain “house-style”. Future research could expand the number and variety of button designs, as well as manipulate additional visual features such as size, contrast, or iconography, to investigate how these interact with color and shape in both congruent and incongruent conditions.

Thirdly, perceived clarity was measured using a single Likert-scale item, which may not fully capture the nature of clarity, including recognition speed or decision confidence. Future studies could incorporate more comprehensive measures, such as response times, accuracy, or confidence ratings, to obtain a richer understanding of how users interpret buttons.

Finally, buttons were presented as isolated images rather than embedded within full websites or applications. In real interfaces, surrounding elements, layout, and interactivity can influence perception, and the tasks themselves were short descriptions rather than real actions, which may reduce validity. Future research could place buttons in realistic digital contexts to explore how environmental factors shape perceived clarity and whether the findings regarding color and shape dominance hold in more naturalistic settings. Longitudinal or repeated-exposure designs could also assess whether users’ reliance on color over shape changes with experience or familiarity.

By addressing these limitations, future studies can refine theoretical models of visual cue processing and provide stronger, more actionable guidance for designing intuitive and effective digital interfaces.

5.6 Conclusion

This study examined how visual match between color and shape, and the congruency of these features with task meaning, influence users’ perceived clarity of website buttons. The findings

reveal a nuanced picture: while visual match alone did not enhance clarity and even reduced it in some cases (H1), congruency between those visual features and the meaning of the task significantly improved clarity (H2). The exploratory subquestion further showed that, when color and shape conflicted, users relied more on color than on shape, highlighting the dominant role of color as an affective and perceptually visual cue.

Theoretically, these results extend understanding of visual cue integration in interface design. They suggest that emotional signals from multiple visual features are not inherently additive. Instead, their interpretive power depends on alignment with task context and learned conventions. Color-in-Context Theory and research on processing fluency help explain why color exerts a stronger influence than shape, while findings from cross-modal congruence, such as the Bouba-Kiki effect, indicate that shape still contributes to perception in a supportive manner.

Practically, the study provides actionable guidance for interface designers. Designers should prioritize color to convey critical actions and ensure that visual cues are consistent with task meaning, while also maintaining a coherent design across the interface. Rounded shapes and conventional visual forms can support clarity, but they are most effective when combined with appropriate color cues.

Overall, this research demonstrates that perceived clarity in interface elements emerges from a complex crossing between visual features, context, and user expectations. Future work that examines diverse populations, more complex designs, and ecologically valid environments will be essential to generalize these findings and refine theoretical models. By integrating these insights, designers and researchers can better understand how to create intuitive, effective, and emotionally coherent digital interfaces.

References

Bar, M., & Neta, M. (2006). Humans prefer curved visual objects. *Psychological Science*, *17*(8), 645–648. https://doi.org/10.1111/j.1467-9280.2006.01759.x

Barrett, L. F. (2004). Feelings or words? Understanding the content in Self-Report ratings of experienced emotion. *Journal of Personality and Social Psychology*, *87*(2), 266–281. https://doi.org/10.1037/0022-3514.87.2.266

Bouhassoun, S., Naveau, M., Delcroix, N., & Poirel, N. (2022). Approach in green, avoid in red? Examining interindividual variabilities and personal color preferences through continuous measures of specific meaning associations. *Psychological Research*, *87*(4), 1232–1242. https://doi.org/10.1007/s00426-022-01732-5

Boyd, K., & Bond, R. (2021). Can micro interactions in user interfaces affect their perceived usability? *European Conference on Cognitive Ergonomics*, *5*, 1–5. https://doi.org/10.1145/3452853.3452865

Bryant, K. (2024). *Rounded corners and why they are here to stay*. Designmodo. https://designmodo.com/rounded-corners/

Buetti, S., Xu, J., & Lleras, A. (2019). Predicting how color and shape combine in the human visual system to direct attention. *Scientific Reports*, *9*(1), 20258. https://doi.org/10.1038/s41598-019-56238-9

Camgöz, N. (2000). Effects of hue, saturation, and brightness on attention and preference [PhD dissertation, Bilkent University]. https://www.academia.edu/108036373/Effects_of_hue_saturation_and_brightness_on_attention_and_preference

Chiu, T., & Chen, S. (2024). Angular vs. Rounded Perception? The Eye-Tracking Study of Cross-Cultural Differences in Visual Perception of the Relationship Between Product Outline and Its

Surface Texture. In *Lecture notes in computer science* (pp. 207–223). https://doi.org/10.1007/978-3-031-60898-8_14

Clarke, T., & Costall, A. (2008). The emotional connotations of color: A qualitative investigation. *Color Research & Application*, *33*(5), 406–410. https://doi.org/10.1002/col.20435

Cockburn, A., Lewis, B., Quinn, P., & Gutwin, C. (2020). Framing Effects Influence Interface Feature Decisions. *Association for Computing Machinery*. https://doi.org/10.1145/3313831.3376496

Ćwiek, A., Fuchs, S., Draxler, C., Asu, E. L., Dediu, D., Hiovain, K., Kawahara, S., Koutalidis, S., Krifka, M., Lippus, P., Lupyan, G., Oh, G. E., Paul, J., Petrone, C., Ridouane, R., Reiter, S., Schümchen, N., Szalontai, Á., Ünal-Logacev, Ö., … Winter, B. (2022). The *bouba/kiki* effect is robust across cultures and writing systems. *Philosophical Transactions: Biological Sciences*, *377*(1841), 1–13. https://www.jstor.org/stable/27096956

Elliot, A. J., & Maier, M. A. (2012). Color-in-Context theory. In *Advances in experimental social psychology* (pp. 61–125). https://doi.org/10.1016/b978-0-12-394286-9.00002-0

Elliot, A. J., & Maier, M. A. (2014). Color Psychology: Effects of Perceiving Color on Psychological Functioning in Humans. *Annual Review Of Psychology*, *65*(1), 95–120. https://doi.org/10.1146/annurev-psych-010213-115035

Fialkowski, B., & Schofield, D. (2024). Considering color: Applying psychology to improve the use of color in digital interfaces. *Art And Design Review*, *12*(04), 306–329. https://doi.org/10.4236/adr.2024.124022

Fisher, G. G., Matthews, R. A., & Gibbons, A. M. (2015). Developing and investigating the use of single-item measures in organizational research. *Journal of Occupational Health Psychology*, *21*(1), 3–23. https://doi.org/10.1037/a0039139

Huang, K., & Chiu, T. (2007). Visual search performance on an LCD monitor: effects of color combination of figure and icon background, shape of icon, and line width of icon border. *Perceptual and Motor Skills*, *104*(2), 562–574. https://doi.org/10.2466/pms.104.2.562-574

Hsueh, C., & Chen, C. (2025). A study on the visual cue designs in rich Notification User interface. In *Lecture notes in computer science* (pp. 90–101). https://doi.org/10.1007/978-3-031-93819-1_7

Jin, T., Zhou, S., Lang, X., He, J., & Wang, W. (2022). Combined effect of color and shape on cognitive performance. *Mathematical Problems in Engineering*, *2022*, 1–12. https://doi.org/10.1155/2022/3284313

Jing, P. (2024). Opponent-Process theory. *The ECPH Encyclopedia of Psychology. Springer*, 1–2. https://doi.org/10.1007/978-981-99-6000-2_987-1

Jonauskaite, D., Epicoco, D., Al-rasheed, A. S., Aruta, J. J. B. R., Bogushevskaya, V., Brederoo, S. G., Corona, V., Fomins, S., Gizdic, A., Griber, Y. A., Havelka, J., Hirnstein, M., John, G., Jopp, D. S., Karlsson, B., Konstantinou, N., Laurent, É., Marquardt, L., Mefoh, P. C., . . . Mohr, C. (2023). A comparative analysis of colour–emotion associations in 16–88-year-old adults from 31 countries. *British Journal of Psychology*, *115*(2), 275–305. https://doi.org/10.1111/bjop.12687

Jonauskaite, D., & Mohr, C. (2025). Do we feel colours? A systematic review of 128 years of psychological research linking colours and emotions. Psychonomic Bulletin & Review, 32(4), 1457–1486. https://doi.org/10.3758/s13423-024-02615-z

Kang, J., Park, Y. E., & Yoon, H. (2022). Feeling Blue and Getting Red: An exploratory study on the effect of color in the processing of emotion information. *Frontiers in Psychology*, *13*, 515215. https://doi.org/10.3389/fpsyg.2022.515215

Keha, E., Aisenberg-Shafran, D., Hochman, S., & Kalanthroff, E. (2025). Age-related differences in information, but not task control in the color-word Stroop task. *Psychonomic Bulletin & Review*, *32*(4), 1551–1561. https://doi.org/10.3758/s13423-024-02631-z

Korala, C. (2024). *The importance of buttons in UI design and their impact on mobile app usability: case study* (pp. 66–72) [University of Moratuwa]. https://doi.org/10.31705/idr.2024.16

Kurosu, M., & Kashimura, K. (1995). Apparent usability vs. inherent usability. *CHI95: Conference on Human Factor inComputing Systems*, 292–293. https://doi.org/10.1145/223355.223680

Manippa, V., & Tommasi, L. (2021). The shape of you: do individuals associate particular geometric shapes with identity? *Current Psychology*, *42*(12), 10042–10052. https://doi.org/10.1007/s12144-021-02297-z

Mathur, A., Acar, G., Friedman, M. J., Lucherini, E., Mayer, J., Chetty, M., & Narayanan, A. (2019). Dark patterns at scale. *Proceedings of the ACM on Human-Computer Interaction*, *3*(CSCW), 1–32. https://doi.org/10.1145/3359183

Meliksetyan, G. (2025). The psychological meaning of color in design: A semantic review. *Main Issues of Pedagogy and Psychology*, *12*(1), 6–28. https://doi.org/10.24234/miopap.v12i1.64

Nissen, A., Riedl, R., & Schütte, R. (2024). Users' reactions to website designs: A neuroimaging study based on evolutionary psychology with a focus on color and button shape. *Computers in Human Behavior*, *155*, 108168. https://doi.org/10.1016/j.chb.2024.108168

Nummenmaa, L., & Hietanen, J. K. (2009). How attentional systems process conflicting cues. The superiority of social over symbolic orienting revisited. *Journal of Experimental Psychology Human Perception & Performance*, *35*(6), 1738–1754. https://doi.org/10.1037/a0016472

O'Connor, Z. (2013). Colour, contrast and gestalt theories of perception: The impact in contemporary visual communications design. *Color Research & Application*, *40*(1), 85–92. https://doi.org/10.1002/col.21858

Palmer, S. E., & Schloss, K. B. (2010). An ecological valence theory of human color preference. *Proceedings of the National Academy of Sciences*, *107*(19), 8877–8882. https://doi.org/10.1073/pnas.0906172107

Palumbo, L., Ruta, N., & Bertamini, M. (2015). Comparing angular and curved shapes in terms of implicit associations and Approach/Avoidance responses. *PLoS ONE*, *10*(10), e0140043. https://doi.org/10.1371/journal.pone.0140043

Peiffer-Smadja, N., & Cohen, L. (2018). The cerebral bases of the bouba-kiki effect. *NeuroImage*, *186*, 679–689. https://doi.org/10.1016/j.neuroimage.2018.11.033

Pravossoudovitch, K., Cury, F., Young, S. G., & Elliot, A. J. (2014). Is red the colour of danger? Testing an implicit red–danger association. *Ergonomics*, *57*(4), 503–510. https://doi.org/10.1080/00140139.2014.889220

Railo, H., Salminen-Vaparanta, N., Henriksson, L., Revonsuo, A., & Koivisto, M. (2011). Unconscious and conscious processing of color rely on activity in early visual cortex: a TMS study. *Journal of Cognitive Neuroscience*, *24*(4), 819–829. https://doi.org/10.1162/jocn_a_00172

Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? Personality and Social Psychology Review, 8(4), 364–382. https://doi.org/10.1207/s15327957pspr0804_3

Saarela, T. P., & Landy, M. S. (2012). Combination of texture and color cues in visual segmentation. *Vision Research*, *58*, 59–67. https://doi.org/10.1016/j.visres.2012.01.019

Smith, M. E., Smith, M. D., & Sobel, K. V. (2022). The classic stroop asymmetry in online experiments. *Psi Chi Journal of Psychological Research*, *27*(2), 133–144. https://doi.org/10.24839/2325-7342.jn27.2.133

Spaak, E., Peelen, M. V., & De Lange, F. P. (2022). Scene context impairs perception of semantically congruent objects. *Psychological Science*, *33*(2), 299–313. https://doi.org/10.1177/09567976211032676

Spiratos, C., & Kořistová, M. (2021). *Navigation user interface design in e-commerce and its impact on customers' satisfaction*. Jönköping University. https://www.diva-portal.org/smash/get/diva2:1566833/FULLTEXT01.pdf

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*(6), 643–662. https://doi.org/10.1037/h0054651

Sutil-Martín, D. L., & Rienda-Gómez, J. J. (2020). The influence of unconscious perceptual Processing on Decision-Making: A New perspective from Cognitive Neuroscience applied to Generation Z. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.01728

Teye, V. Q. N., & Esseku, J. F. (2023). The Psychology of Colour in Design: Understanding the emotional impact of colour choices. *IOSR Journals*, *28*(6). https://www.iosrjournals.org/iosr-jhss/papers/Vol.28-Issue6/Ser-3/F2806035155.pdf

Thorpe, S., Fize, D., & Marlot, C. (1996). Speed of processing in the human visual system. *Nature*, *381*(6582), 520–522. https://doi.org/10.1038/381520a0

Vainio, L., Mo, X., & Vainio, M. (2025). Is Kiki angry and Bouba happy? Association between emotions, shapes, and sounds. *Psychological Research*, *89*(4), 124. https://doi.org/10.1007/s00426-025-02158-5

Wexner, L. B. (1954). The degree to which colors (hues) are associated with mood-tones. *Journal of Applied Psychology*, *38*(6), 432–435. https://doi.org/10.1037/h0062181

Wielgopolan, A., Pastwa, M., Żuk, D., & Imbir, K. K. (2025). Emotional Stroop Test in online and offline experimental procedures: the comparison of two different modes of conducting studies. *Language and Cognition*, *17*. https://doi.org/10.1017/langcog.2024.77

Wright, P., Mosser-Wooley, D., & Wooley, B. (1997). Techniques & tools for using color in computer interface design. *XRDS Crossroads the ACM Magazine for Students*, *3*(3), 3–6. https://doi.org/10.1145/270974.270976

Xiao, H., Sun, Y., Duan, Z., Huo, Y., Liu, J., Luo, M., Li, Y., & Zhang, Y. (2024). A study of model iterations of Fitts' Law and its application to Human–Computer Interactions. *Applied Sciences*, *14*(16), 7386. https://doi.org/10.3390/app14167386

Zhang, M., Gong, Y., Deng, R., & Zhang, S. (2022). The effect of color coding and layout coding on users' visual search on mobile map navigation icons. *Frontiers in Psychology*, *13*, 1040533. https://doi.org/10.3389/fpsyg.2022.1040533

Appendices

Appendix A: Sentiment analysis results

Core sentence	Magnitude	Sentiment Score
Join Now	1.00	0.733
Yes I agree	0.86	0.656
Claim your Reward	0.76	0.603
Join for Free	0.55	0.504
View Details	0.00	0.250
Download	0.00	0.250
Learn More	0.01	0.248
Go to Next	0.22	0.196
No thanks	0.99	-0.640
Decline	0.84	-0.669
Delete Account	0.98	-0.727
Disable	0.99	-0.746

Note. This sentiment analysis is from Text2Data.com (*https://text2data.com/Demo*).

Appendix B: Survey

Welcome!

Thank you for participating in this study.

Before we begin, we'd like to give you a brief overview of what to expect and how your information will be handled. In this study, we are interested in exploring the user experience of buttons on websites and online platforms. You will be presented with a variety of buttons and asked to evaluate how clearly each one communicates its intended action. Your responses will reflect your personal impressions and help us understand how different designs are perceived.

Your responses will be kept completely confidential. Your participation in this research is voluntary. You have the right to decline to participate or withdraw at any point during the study without negative consequences or explanation. Additionally, you have the right to request access and to rectification, erasure, restriction of, or object to the processing of your data. The information we collect with the survey will only be accessible to the researchers who conduct this study. This data will be collected and processed through Qualtrics, and may be stored for 1 year.

If you have any questions or need further information, please contact:
j.vanfraeijenhove@tilburguniversity.edu

This survey contains Karma for SurveySwap and points for SurveyCircle

By clicking the button below, you acknowledge:
- You have read the introduction
- You are at least 18 years old
- You are aware of the possibility of asking questions
- Your participation in the study is voluntary
- You give permission for your data to be processed as described above
- You are aware that you may terminate your participation at any time for any reason
- You are aware that you will receive no compensation for your participation

() Yes, I have read and understood the information provided, and I consent to participate in this study.

() No, I do not want to participate

What is your age?

_____

What is your gender?

() Male () Female () Non-binary / third gender () Prefer not to say

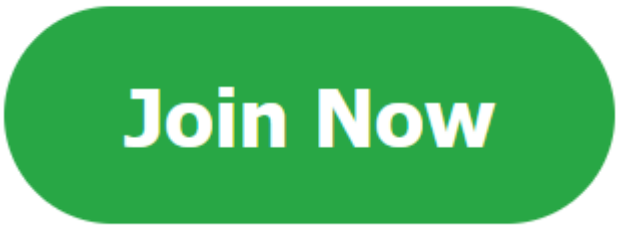
Introduction

You will now be shown 8 different buttons, similar to the buttons you would normally encounter on websites or online platforms. They will be presented one by one. Each button represents a specific action, and the description of that action is placed above the button image so you know what it is meant to do.

For each button, please indicate how clearly the button communicates the action it is meant to perform. We are interested in your first impressions and intuitive judgments, so go with what feels most obvious to you.

Manipulation

The following button signs you up for a membership to a charity:



Looking at the visual design of the button, how clear do you perceive the corresponding action?

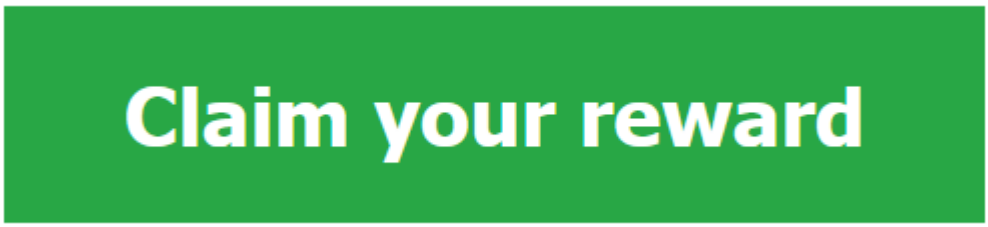
() Extremely unclear - - - - - - -()- - - - - - -()- - - - - - -() - - - - - - -() - - - - - - -()- - - - - - - () Extremely clear

The following button confirms that you agree to join a shared playlist with your friends:

Looking at the visual design of the button, how clear do you perceive the corresponding action?

() Extremely unclear - - - - - - -()- - - - - - -()- - - - - - -() - - - - - - -() - - - - - - -()- - - - - - - () Extremely clear

The following button lets you collect a discount coupon after completing a short survey:



Looking at the visual design of the button, how clear do you perceive the corresponding action?

() Extremely unclear - - - - - - -()- - - - - - -()- - - - - - -() - - - - - - -() - - - - - - -()- - - - - - - () Extremely clear

The following button creates a free account so you can try out a new learning platform:

Looking at the visual design of the button, how clear do you perceive the corresponding action?

() Extremely unclear - - - - - - -()- - - - - - -()- - - - - - -() - - - - - - -() - - - - - - -()- - - - - - - () Extremely clear

The following button skips an offer when the website asks if you want to try a premium trial:

Looking at the visual design of the button, how clear do you perceive the corresponding action?

() Extremely unclear - - - - - - -()- - - - - - -()- - - - - - -() - - - - - - -() - - - - - - -()- - - - - - - () Extremely clear

The following button rejects an optional insurance during checkout:

Looking at the visual design of the button, how clear do you perceive the corresponding action?

() Extremely unclear - - - - - - -()- - - - - - -()- - - - - - -() - - - - - - -() - - - - - - -()- - - - - - - () Extremely clear

The following button removes your account on a platform:

Looking at the visual design of the button, how clear do you perceive the corresponding action?

() Extremely unclear - - - - - - -()- - - - - - -()- - - - - - -() - - - - - - -() - - - - - - -()- - - - - - - () Extremely clear

The following button stops email notifications from arriving in your inbox:

Looking at the visual design of the button, how clear do you perceive the corresponding action?

() Extremely unclear - - - - - - -()- - - - - - -()- - - - - - -() - - - - - - -() - - - - - - -()- - - - - - - () Extremely clear

How clear or unclear did the buttons feel to you personally, and what aspects of the design influenced your impression?

_____

In your opinion, what makes a button easy to understand or use?

_____

Debriefing

Thank you for taking part in this study. Your response has been recorded!

The goal of this survey is to understand how people interpret and evaluate the clarity of website buttons based on their visual design, specifically their color and shape, and the connection to the task. By analyzing your responses, we aim to identify if and how design elements make buttons feel clearer and more intuitive to users.

If you have any questions or comments regarding the study or the survey, or you would like to receive the results of the study, feel free to contact the researcher at: j.vanfraeijenhove@tilburguniversity.edu

Thank you again for your time and valuable input!

SurveyCircle: [code]

SurveySwap: [code]