EXPLORING THE EMOTIONAL IMPACT OF WEB LOADING PAGE COLOURS, BRIGHTNESS VALUES, AND ICON SHAPES WITH PUPILLOMETRY

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ABSTRACT
Design students frequently rely on subjective peer-based "good" or "bad" assessments of their design projects. This study tests different web-loading screens to assess how background colour, brightness value, and loading-icon shape affect participants' emotional responses. Twenty university undergraduates viewed twenty randomised pages of five background colours and one neutral colour, rendered at 100% and 50% opacity, and two icon shapes in a controlled presentation. Participants' affective responses to each loading page were assessed in two ways: measuring pupil dilation with Tobii eye-tracking glasses (pupillometry) and self-reporting their emotional experience. The results showed, on average, blue and green colours were associated with positive emotions, red and yellow with negative emotions, and black and grey with neutral emotions. The lighter brightness values of each colour ranked more positively on average than their darker counterpart. Icon shape differences had little impact on emotional responses. Pupil dilation changes showed, on average, that the yellow and red pages cause greater arousal than the green and blue pages. These findings demonstrate that simple design element adjustments in colour and brightness impact users' affective states during web page loading wait time. By combining objective and subjective methods, this work offers actionable guidelines for students to assess their users' experiences if replicated in a classroom setting. Instructors may help students understand how technology allows designers to quantify emotional reactions to their designs and challenge students' traditional design decision-making choices.

Keywords: Pupillometry, design education methods, colour & shape psychology, user experience measurement, objective–subjective correlation

1 INTRODUCTION
Web design has long been associated with functionality and usability, often prioritising efficiency over emotional engagement. However, design is not just about utility, it is also a powerful medium for evoking emotions, much like postmodern architecture and art. Designers such as Alessandro Mendini and Ettore Sottsass demonstrated how colour, shape, and form could provoke visceral emotional reactions in viewers [1]. Furthermore, design students usually give and receive critiques based on these criteria, as they are easy to quantify. Frequently, students rely on subjective judgements of their work when testing their website design elements. The designs' typography, layout, or colour scheme are often evaluated by fellow design students, who offer critiques based on reductive standards such as "good," "bad," or "cool." If critiques are offered on aesthetic or emotional impact, they are typically subjective. While emotion may be challenging to measure, this study explores how students can measure users' reactions to their designs. Can a website's design elements, its colours, shapes, and values, elicit specific emotional responses such as excitement, fear, or anger without relying on textual content? If so, how can designers learn to accurately measure these emotional responses and leverage them to enhance user experience and engagement?
One of the key psychological concepts underlying this research is priming [2], the idea that exposure to a stimulus influences a person's subsequent response to related stimuli. In art and architecture, bright colours and exaggerated forms can create feelings of joy and energy, while dark, sharp, and asymmetrical shapes might evoke discomfort or unease [3]. This study will investigate whether specific design element choices can unconsciously prime users for increasingly positive or negative emotional responses. The study examines how cool versus warm colours and rounded versus angular shapes affect

user perception [4] and how design choices like darker or lighter colours influence emotional response [5]. Additionally, we will explore an often-overlooked element of the web experience: loading pages. While the ideal loading time is instantaneous, waiting is still inevitable in digital interactions. Can they be designed to evoke anticipation or excitement rather than frustration?

Our experimental study aims to determine how changing the background colours, brightness values, and icon shape of a web-loading page content influences user emotions. Participants will self-report emotional scores for each option. In addition, pupillometry, changes in pupil dilation, will be measured using eye-tracking technology. Larger pupil dilation equates to higher arousal, while smaller dilation equates to lower arousal [6]. The physiological responses will be aligned with their self-reported responses, enabling subjective and objective measurement of the participants' emotions to help determine each stimulus's positive and negative arousal. The findings will provide insights into the emotional impact of specific web design elements and demonstrate how students can use technology to assess user experience objectively.

2 METHOD

2.1 Participants

Twenty undergraduate students from Brigham Young University and Utah Valley University between the ages of 18 and 30 participated in the study. Eight of the students were male, and twelve were female.

2.2 Study Setup

The study used Tobii 3 adjustable eye-tracking glasses, Figma, and a 15.6" ASUS laptop with a 1920 × 1080 resolution 10-bit RGB display in an SDR colour space. The glasses are connected by wire cable to a Tobii battery and through Wi-Fi to a nearby laptop to record each participant's experience. To calibrate the glasses, participants focused on a small white card with a black dot surrounded by a circle in the centre. Once calibrated, the glasses begin recording, and participants would start and view the automated presentation of different loading pages. The room's lighting and the laptop screen's brightness were kept consistent for the duration of the study. The loading screens consisted of one of ten solid background colours selected and a white "loading icon," either a circle or a triangle, with a white path moving clockwise around the form, completing a 360-degree rotation every 1.2 seconds as shown in Figure 1. The shapes themselves did not move and were in the identical location on each page.

Figure 1. The left image shows still images of the two animated icons. The middle and right images show the two icons as the participants saw them on the screen

The colours shown in Figure 2 are black, blue, yellow, red and green. They were selected from the ISCC-NBS system to maintain standardised, distinguishable hues [7]. Each colour opacity was reduced to 50% to generate the five lighter-value colours.

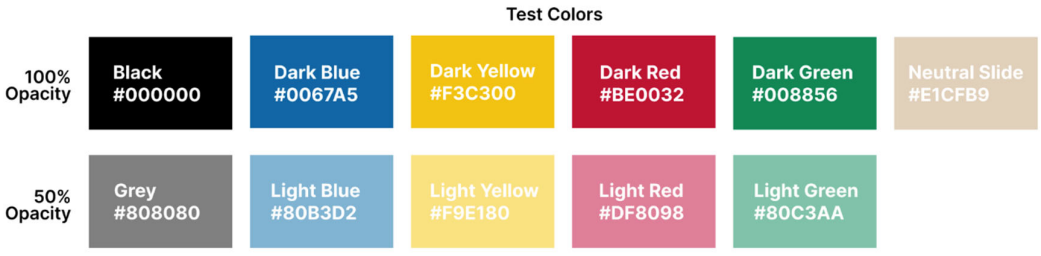

Figure 2. The ten colours used in testing with their associated names and hex codes, and the one neutral colour used between colour screens

The testing stimulus included ten colours, each with a circle and triangle icon, resulting in twenty loading screen options. Each loading screen was assigned a number from one to twenty and randomised into one of three presentations using an online random number generator. The presentation screens were timed and automatically moved forward for the participants. Each loading screen was shown for five seconds, and then a neutral screen appeared for five seconds before moving to the next loading screen. The neutral screen allowed participants' pupil diameter to return to baseline. Beige was chosen as the neutral slide because white was too light and would throw off the baseline, and grey was one of the colours already used for testing. Each participant was randomly assigned to one of the three presentations (Group 1 saw presentation 1, etc). The participants would then verbally score their emotional response to each screen on a scale from one to five, with one being negative, five being positive, and three being neutral. Participant scores were recorded according to the presentation.

2.3 Analysis

Researchers compiled the verbal survey responses into a spreadsheet for data analysis. The pupil diameters were collected using Tobii software and exported to the spreadsheet. Researchers synthesised and assessed the data numerically and visually as a team to uncover patterns and insights. While this study offers valuable insights, the small sample size may constrain the generalisability of the results. The uneven ratio of male to female participants may have introduced a bias related to gender differences in emotional perception or expression. In addition, although stimuli were randomised into three presentation orders, order effects may have influenced participants' responses.

3 RESULTS

3.1 Background Colour Scores

The self-reported scores for each loading page were naturally separated into three colour groups, as reported in Figure 3. The blue and green backgrounds scored above the midpoint, and the red and yellow backgrounds below the midpoint. The blacks mostly scored at the midpoint, except for the grey triangle, which scored in the middle of the red and yellow scores. The average score for all the blue and green background colours is 3.509. The average score for all the red and yellow colours is 2.456. The difference between these two averages is 1.052. The average colour of blacks and greys is 2.850.

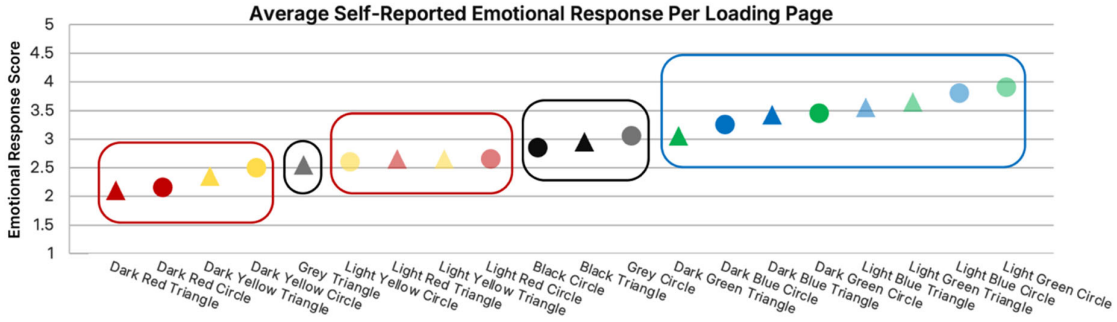

Figure 3. Reports the average self-reported emotional response per loading page

3.2 Light vs Dark Background Colour Scores

The average self-reported scores for the darker-coloured backgrounds are 2.807, and the lighter-coloured backgrounds are 3.105. The difference between the averages is 0.298. The lighter-coloured backgrounds scored higher 9 out of 10 times, with the dark black triangle being the one colour scoring better than the light colour. The green triangle reported the greatest score difference. These scores are reported in Figure 4.

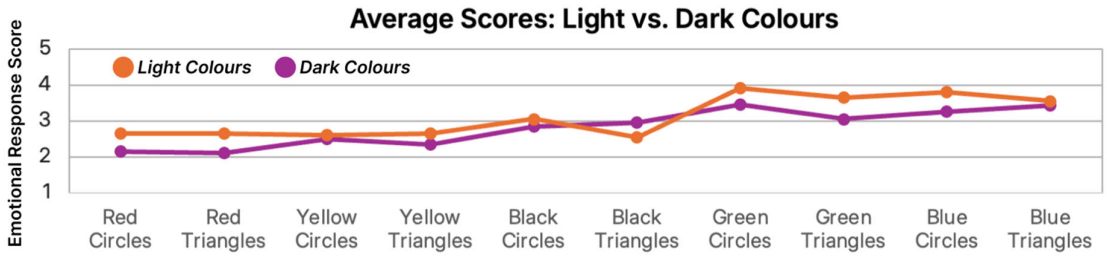

Figure 4. Reports Light vs Dark Colour Background Scores

3.3 Triangle vs. Circle-Shaped Icon Scores

The average self-reported score for loading screens with circular icons is 3.020, and the triangular icons are 2.892. The difference between the averages is 0.128. Circular icons were ranked higher than the triangle icons 7 out of 10 times. The grey triangle and circle showed the greatest difference in scores. These scores are reported in Figure 5.

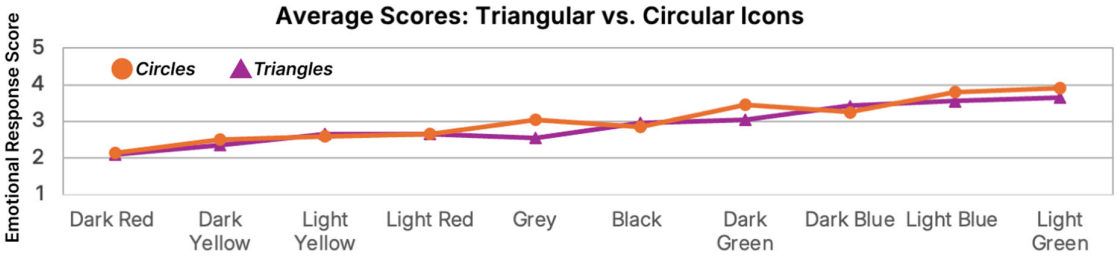

Figure 5. Triangle vs. Circle Shaped Icon Scores

3.4 Pupil Dilation Scores

The pupil dilation outcomes are reported in Figure 6. This graph combines the average highest change in pupil diameter (measuring objective biomechanical arousal) within the first second of seeing each new loading screen with the average self-reported scores (measuring subjective emotional impact) of the same loading screen. Among the observed pupil change rates, the largest deviations from zero were found among the Grey Triangle (0.626 mm/sec), Yellow Triangle (-0.601 mm/sec), Light Blue Circle (0.586 mm/sec), and Red Triangle (0.510 mm/sec). The rest of the screens scored between -0.255 and 0.364 mm/sec.

4 DISCUSSIONS

4.1 Background Colour

The background screen colour demonstrated the greatest impact on the participants, with blue and green backgrounds associated with more positive emotions and the red and yellow backgrounds more frequently linked to negative emotions (Fig. 3). The red and yellow backgrounds also displayed a wider range of pupil diameter change rates (Fig. 6), indicating that they caused heightened physiological responses more frequently than green and blue colours. Black and grey scored between the blue/greens and red/yellows (Fig. 3). Findings suggest that to induce users' calm and positive reactions to a loading page, blue and green colours should be used. These results align with prior research suggesting that cooler colours are perceived as calming and positive, whereas warmer colours can evoke heightened emotional states, including discomfort and urgency [8]. However, the results challenged the researchers' personal preferences in colours, who were convinced that warm colours would result in positive emotions, underscoring the educational benefit of this study. This outcome suggests, students using this assessment process may disrupt their personal bias and thus foster increased critical and intentional decision-making in colour use.

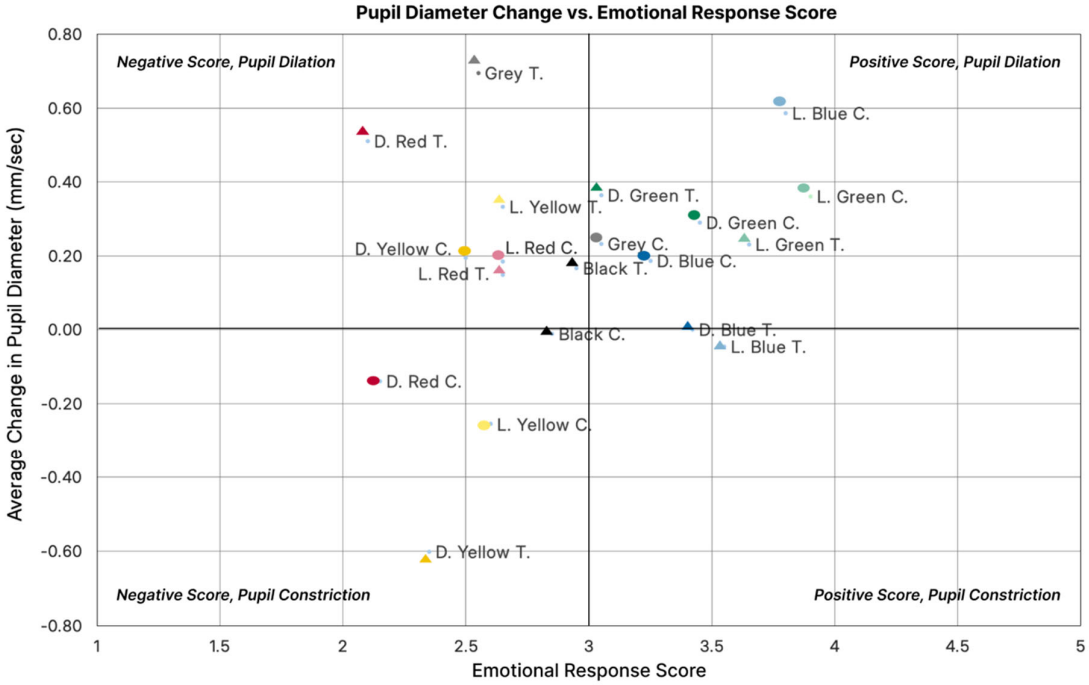

Figure 6. Reports survey scores in relation to participants' rate of change in pupil diameter in combination with self-reported emotional impact per loading screen

4.2 Light vs Dark Background Colours

The colour brightness value results were more nuanced. Lighter values were consistently ranked more positively than darker values, suggesting that lightness is associated with more positive emotions (Fig. 4). The average rate of change in pupil diameter for both light and dark colours was scattered in broad ranges, and no apparent pattern was observed (Fig. 6). Consequently, designers might aim to use lighter colours when designing to create positive subjective responses.

4.3 Triangle vs. Circle-Shaped Icons

The icon shapes appeared to have the least significant effect on emotional responses. While circular icons were rated slightly higher than triangular ones, the differences were minimal, and even less compelling were the pupil diameter results (Fig. 5, Fig. 6). Again, this challenged the student researchers' initial hopes that the novelty of the triangular loading icon would garner more positive responses than the industry standard circle. Consequently, student designers should test their novel ideas with quantitative processes to know if their new design creates the intended reaction with users. Additionally, the simplicity of the shapes used, circles and triangles, may not have provided enough contrast to elicit strong affective differentiation. After the experiment, one of the participants asked what we were measuring, and we answered, the different shapes and colours. The participant responded that she didn't consciously realise there were different shapes until we told her, but she could recall the two shapes used after thinking about them. Future studies could explore the value and scale of shapes further.

4.4 Pupil Dilation

The pupillometry change rates per screen indicate the amount of emotional arousal participants experienced. Higher rates of change in pupil diameter are often associated with higher emotional arousal (negative or positive), whereas near-zero rates of change indicate a neutral emotional response. Changes in the negative direction result from pupil constriction and are associated with reduced arousal, which could relate to boredom, relaxation, or disinterest [9]. Therefore, the largest deviations from zero show which screens generated the most intense emotions. Based on the Red Triangle screen's low average participant score and high rate of pupil diameter change (Fig. 6), it could be assumed that participants experienced stronger negative emotions such as disgust, frustration, or anxiety during the presentation of that screen. With similar reasoning, the Light Blue Circle screen could be considered to have inspired

strong positive emotions such as surprise or excitement (Fig. 6). Because the Yellow Triangle screen has a large deviation from zero in the negative direction and received a low average participant score, this could mean that it elicited feelings of intense boredom (Fig. 6). However, the rates of change in pupil diameter while watching the loading screens were not extreme on average suggesting that the participants were not often emotionally stimulated by the designs. However, the rates of pupil diameter change were relatively moderate on average, indicating that the participants were rarely experiencing strong emotions during the study. These findings suggest that while participants may have reported extreme emotional responses to certain screens, their physiological data contradicts those scores. This highlights the value of incorporating objective measures like pupil dilation alongside self-reported data. By doing so, student designers may sift through the feedback given by participants to find which scores were impactful.

5 CONCLUSIONS

This study provides evidence that background colour and brightness on loading screens influence users' emotional experiences. Blue and green were associated with more positive self-reported emotions, whereas red and yellow were linked to more negative emotional responses. Lighter values were also generally ranked more emotionally positively than darker ones. While shape had the least measurable impact, the preference for circular icons over triangular ones suggests that form may still play a secondary role in emotional engagement and may be worth further exploration. These findings highlight the potential of colour and value in directing emotion in users. However, pupillometry recorded limited emotional arousal in response to most screens, suggesting that designers could experiment with more unconventional design choices to elicit stronger emotions. Measuring physiological responses enhances the subjective measurements, allowing students to validate or refute the impact of their design element decisions. This study provides practical insights for educators and practitioners to improve design assessments. Integrating quantitative methods into design critique sessions enables improved design outcomes. Future work may expand on icon shape variety and scale, motion characteristics, and contextual uses to further refine how design elements shape overall user satisfaction.

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