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Aesthetics, emotions and engagement: A high-fidelity prototype study on digital product interface

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Abstract

This study examines the intersection of aesthetics, emotion, and functionality in digital design, investigating how high-fidelity visual elements influence user affect and perceived usability. Grounded in the Aesthetic-Usability Effect and Emotional Design Theory, the literature suggests that attractive interfaces trigger positive emotional responses that broaden cognitive processes and enhance functional perception. This research addresses a gap in psychologically informed design by asking how specific manipulations of colour, typography, and whitespace influence a user's emotional state and system engagement.

It was hypothesized that prototypes featuring warm colours, simple typography, and ample whitespace would evoke significantly higher positive affect, correlating with higher System Usability Scale scores and user preference. Using a within-subjects design, N=160 participants evaluated two high-fidelity website prototypes—Website 1 (Positive Aesthetics) and Website 2 (Negative Aesthetics). Data were analysed using Repeated Measures ANOVA, Pearson Correlation, and Linear Regression.

Results demonstrate a significant main effect for valence ($p < 0.001$), with positive iterations evoking substantially higher affect. Colour and Typography were dominant drivers; positive colour achieved the highest mean rating ($M=4.06$) and preference (43.1%). Regression confirmed that positive affect significantly predicts usability, explaining 30.3% of score variance ($R^2 = 0.303$, $p < 0.001$), validating the Halo Effect.

Keywords: Aesthetic-Usability Effect; Perceived Usability; High-Fidelity Prototyping; System Usability; User Interface Optimisation; Digital Psychology

1. Introduction

In today's competitive digital landscape, a product's success depends not only on functionality but also on its capacity to form emotional connections with users. The longstanding heuristic "what is beautiful is usable" [28] highlights the value of aesthetics, yet emotion that are central to quick judgments of good or bad, interacts deeply with reasoning [31]. Emotional design is now viewed as a strategic necessity rather than an aesthetic luxury, with up to 95% of purchasing decisions influenced by emotion [51, 5], driving loyalty, retention, and advocacy.

Despite growing recognition of aesthetics' role, a significant research gap remains in understanding how specific design elements (colour, typography, and whitespace) independently influence users' emotions. Without empirical data, designers rely on subjective intuition, producing inconsistent outcomes. Existing insights are largely qualitative, and previous research has often prioritised colour while neglecting other visual factors or their comparative emotional

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impact. Quantitative evidence is therefore needed to guide design decisions that deliberately evoke targeted emotional responses.

Several theoretical frameworks inform this domain. Norman's Emotional Design Theory identifies three processing levels that are visceral, behavioural, and reflective, each shaping how users perceive and engage with a product [31]. Usability frameworks such as Nielsen's Heuristics and ISO 9241 standards further link aesthetic quality to engagement and ease of use [30, 14]. Cognitive psychology principles, including Gestalt theory and Cognitive Load Theory, explain how visual organisation reduces mental effort and enhances clarity [7, 22]. The Aesthetic-Usability Effect [28] demonstrates that visually appealing interfaces are perceived as more usable through mechanisms such as positive affect, tolerance for minor flaws, and the halo effect. Van Der Lee and Van Enschoot [46] further extended the BRECVEMA framework to visual design, illustrating how perceptual, cognitive, and emotional inputs interact to shape aesthetic experience.

This study addresses this gap through a controlled, prototype-based investigation measuring the specific impact of aesthetic variables (colour, typography, and whitespace) on users' emotional responses and perceived usability, ultimately contributing to a more psychologically informed approach to digital product design.

Objectives

- To design and develop high-fidelity visual prototypes in a functional website system that manipulates specific aesthetic elements (colour, typography, and whitespace) for analysis.
- To assess the emotional states evoked by each aesthetic prototype.
- To evaluate the perceived usability of the system's aesthetics.
- To examine the relationship between users' emotional states and their perceived usability of the system.

Hypothesis

- **H1:** A digital product prototype featuring a warm colour scheme will evoke significantly higher positive affect.
- **H2:** A digital product prototype utilising highly legible and simple typography will evoke significantly higher positive affect.
- **H3:** A digital product prototype with ample whitespace and a minimalist layout will evoke significantly higher positive affect.
- **H4:** Digital product prototypes that evoke higher positive affect will also achieve significantly higher scores on the System Usability Scale.
- **H5:** Participants will prefer and rank highest the digital product prototype that evokes the highest positive affect.

2. Methodology

2.1. Research Design

The study follows a Quasi-Experimental Within-Subject Design, meaning each participant was exposed to all prototype conditions. A quantitative approach was used for all data collection and analysis.

2.2. Participants and Sampling

The final sample consisted of $N = 160$ participants who met all inclusion criteria, comprising 78 males and 82 females. Gender was the primary demographic variable recorded. This study employed a non-probability convenience sampling method to recruit participants. The sample was limited to adults aged 18 and above who were proficient in English and comfortable using digital platforms, ensuring participants could meaningfully engage with and respond to the prototypes. Individuals with visual impairments such as colour blindness were excluded, as their perception of colour (a key aesthetic variable) may differ significantly from the general population. Those with diagnosed cognitive or neurological conditions such as dyslexia or ADHD were also excluded, given the potential influence of these conditions on how typography and layout are processed. Additionally, individuals with severe mental health conditions such as depression, bipolar disorder, or schizophrenia were excluded, as these may affect emotional responses in ways that could confound the study's findings.

2.3. Measures/ Instruments

The tool used for the creation of the website was WordPress. The questionnaire used for system usability was the System Usability Scale (SUS) [6]. The System Usability Scale developed by John Brooke [6] has demonstrated strong psychometric properties across diverse domains. The scale shows high internal consistency, with Cronbach's alpha values typically ranging from 0.83 to 0.97, indicating excellent reliability. In terms of validity, the SUS demonstrates good content validity through its coverage of key usability dimensions (e.g., complexity, ease of use, confidence), as well as strong construct and concurrent validity, evidenced by significant correlations with other established usability and satisfaction measures. These findings support the SUS as a reliable and valid instrument for assessing perceived usability [6].

2.4. Procedure and Ethical Considerations

Data collection was conducted through Google Forms to ensure standardised stimulus delivery and efficient data management, divided into two phases followed by post-exposure questions. In the first phase, participants were presented with visual prototypes one at a time in a randomised order to minimise order effects and systematic bias, rating their emotional response to each using a custom 6-level affect scale immediately after viewing. In the second phase, participants were provided with two website links, one representing positive aesthetics and one representing negative aesthetics, and were asked to navigate both before completing a System Usability Scale (SUS) questionnaire for each. Following both phases, all prototypes were displayed again sequentially, and participants provided a numerical rating from 1 to 5 for each, identified their most preferred prototype, and offered a written justification for their choice.

The study was conducted in accordance with established psychological research ethics to ensure participant safety and dignity throughout. Prior to commencing the form, participants were fully briefed on the study's purpose, the nature of the tasks, and how their data would be used, and were explicitly informed of their right to withdraw at any time without penalty. Given that the stimuli involved mental health website prototypes, all content was carefully curated to avoid triggering adverse psychological responses, and the emotional rating scale was deliberately designed using moderate language, for instance using the term "unpleasant" rather than "distressing", to ensure the evaluation process itself did not cause undue anxiety. No personally identifiable information was collected; responses were coded and stored securely, used exclusively for this dissertation, and will be disposed of in accordance with institutional guidelines upon project completion. Participants were fully informed that they were evaluating design prototypes, and no covert manipulation of behaviour or psychological state was employed beyond what was explicitly disclosed in the consent briefing.

2.5. Data Analysis

Descriptive statistics were used to establish baselines, including means (M) and standard deviations (SD) for each aesthetic rating and total SUS score, frequency distributions for categorical preferences, and assessments of skewness and kurtosis to evaluate the normality of response distributions.

Inferential statistics were employed to test the five research hypotheses. A Two-Way Repeated Measures ANOVA served as the primary test for hypotheses H1, H2, and H3, examining the main effects of design elements and valence as well as their interaction on emotional affect, with Greenhouse-Geisser corrections applied where Mauchly's Test of Sphericity indicated a violation of assumptions. A Wilcoxon Signed Ranks Test provided a non-parametric comparison of total SUS scores between the positive aesthetics website and the negative aesthetics website, assessing both the direction and magnitude of differences in participant ratings. A Pearson Correlation was conducted to examine the strength and direction of the relationship between positive emotional affect and perceived usability in relation to H4. Finally, a Linear Regression Analysis was used to determine the extent to which positive emotional affect could predict overall SUS scores, with model significance verified through ANOVA F-tests and standardised beta coefficients.

The study utilised two custom measurement instruments. The first was a 5-point affect scale applied to the visual prototypes in Part 1, where a score of 5 reflected a strongly positive emotional response associated with feelings of delight, inspiration, and serenity; a score of 3 indicated a neutral-positive response characterised by pleasantness, calm, and comfort; a score of 2 represented a neutral state of indifference or being uninspired; a score of 1 denoted a mildly negative response described as unpleasant, off-putting, or slightly awkward; and a score of 0 captured a strongly negative response associated with finding the design undesirable, unappealing, or discouraging. The second instrument was the System Usability Scale used in Part 2, scored according to standard SUS conventions. For odd-numbered items (1, 3, 5, 7, and 9), responses were coded from 0 for Strongly Disagree through to 4 for Strongly Agree. For even-numbered items (2, 4, 6, 8, and 10), the scoring was reversed, with 0 assigned to Strongly Agree and 4 assigned to Strongly Disagree, reflecting the negatively worded nature of those statements.

3. Results and Discussion

3.1. Descriptive

Mean ratings confirm that positive colour and typography are the strongest drivers of positive affect. Positive Colour achieved a total sample mean of 4.06 versus 2.37 for its negative counterpart, while Positive Typography scored 3.78 against 2.76. Within the group that explicitly preferred typography (N = 37), the positive iteration reached a mean of 4.59, suggesting that legible, simple typography is a critical factor in evoking positive emotional states and supporting H1 and H2. Notably, participants preferring positive typography gave colour its highest external rating (M = 4.46), indicating a degree of cross-element sensitivity among aesthetically attuned users.

Whitespace presented a more nuanced picture. Although the group explicitly preferring positive whitespace (N = 17) rated it highly (M = 4.82), the total sample mean for positive whitespace (3.18) was marginally lower than for negative whitespace (3.24). Participants who prioritised colour or typography actually rated negative whitespace higher than its positive counterpart, suggesting that for the broader user base, whitespace is a more subjective and secondary concern than the immediate visual impact of colour or text — partially supporting H3 for a specific subset of users rather than the full sample.

Across all groups, participants consistently rated prototypes highest when their preferred aesthetic element was executed positively. The Positive Colour group rated their preference at 4.28 versus 2.35 for the negative version; the Positive Whitespace group rated theirs at 4.82 versus 3.00. This pattern provides strong evidence for H5, confirming that users maintain a significantly higher preference for prototypes that deliver positive affect through their primary aesthetic driver.

3.2. Gender Based Analysis Of Aesthetic Variables And System Evaluation

Gender analysis reveals distinct patterns in how male and female participants responded to aesthetic elements and overall system quality. Males (N = 78) reported higher mean ratings for the primary positive aesthetic drivers — Positive Colour (M = 3.37, SD = 0.791) and Positive Typography (M = 3.29, SD = 0.982) — compared to females (N = 82), who rated the same elements at 3.12 and 3.01 respectively. This trend inverted for layout, with females showing greater appreciation for Positive Whitespace (M = 2.88, SD = 0.999) than males (M = 2.65, SD = 0.835). Both genders scored Negative Colour lowest, though males were more critical (M = 1.74) than females (M = 1.95).

Males were also more punitive toward negative design elements overall, rating Negative Typography at 1.71 and Negative Whitespace at 2.36, while females were more moderate at 2.45 and 2.77 respectively. These perceptual differences carried through to system-level evaluations. Website 1 (positive aesthetics) achieved a total mean usability score of 73.46 (SD = 20.430), compared to 44.07 (SD = 23.063) for Website 2 (negative aesthetics).

The gender breakdown of system scores reflects a more polarised response among males, who rated Website 1 at 76.35 and Website 2 at just 39.28, while females provided a narrower range of 70.71 and 48.62 respectively. These findings support H4, demonstrating that positive aesthetic affect — particularly through colour and typography — directly translates to higher perceived usability, with male participants exhibiting greater overall sensitivity to aesthetic quality.

3.3. Comparative Analysis Of System Prototypes

Table 1 Rank

		N	Mean Rank	Sum of Ranks
Web 2 Total – Web 1 Total	Negative Ranks	118 ^a	77.68	9166.50
	Positive Ranks	26 ^b	48.98	1273.50
	Ties	16 ^c		
	Total	160		

A. Web 2 Total < Web 1 Total; B. Web 2 Total > Web 1 Total C. Web 2 Total = Web 1 Total

Table 2 Test Statistics^a

	Web 2 Total - Web 1 Total
Z	-7.872 ^b
Asymp. Sig. (2-tailed)	0.000

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

To further examine the significance of the difference between the two prototypes, a Wilcoxon Signed Ranks Test was conducted to compare the total scores of Website 1 (Positive Aesthetics) and Website 2 (Negative Aesthetics). The results indicate a statistically significant preference for the high-fidelity prototype with positive aesthetic variables.

Out of the 160 participants, 118 showed a negative rank, meaning their score for Website 2 was lower than their score for Website 1, with a mean rank of 77.68. Conversely, only 26 participants scored the negative prototype higher, and 16 participants recorded no difference between the two systems. The test statistics confirm this significant disparity ($Z = -7.872$, $p < 0.001$), providing robust evidence to reject the null hypothesis and support H4. This confirms that the manipulation of specific aesthetic elements—colour, typography, and whitespace—effectively influences a user's emotional state and their subsequent perception of the system's usability.

3.4. Analysis Of Aesthetic Variables

A two-way repeated measures ANOVA was conducted to examine the effect of three design elements (Colour, Typography, and Whitespace) and two levels of valence (Positive and Negative) on user emotional affect.

The descriptive statistics indicate that Positive iterations consistently outperformed Negative ones for both Colour ($M = 3.24$ vs. 1.85) and Typography ($M = 3.15$ vs. 2.09). However, the difference was much narrower for Whitespace ($M = 2.77$ for Positive vs. 2.57 for Negative), suggesting that the valence of whitespace has a less pronounced impact on affect than other variables.

Table 3 Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	Positive Total ^b	.	Enter

a. Dependent Variable: WEB 1 TOTAL

b. All requested variables entered.

Table 4 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.551 ^a	0.303	0.299	17.105

a. Predictors: (Constant), Positive Total

Table 5 ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20136.198	1	20136.198	68.826	0.000 ^b
	Residual	46225.496	158	292.566		
	Total	66361.694	159			

a. Dependent Variable: WEB 1 TOTAL; b. Predictors: (Constant), Positive Total

Table 6 Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	16.968	6.942		2.444	.016
	Positive Total	6.165	0.743	0.551	8.296	.000

a. Dependent Variable: WEB 1 TOTAL

The regression model further quantifies this impact, with Positive Total serving as the predictor for Website 1 Total.

- **Model Fit:** The Model Summary indicates an R^2 of 0.303, meaning that approximately 30.3% of the variance in perceived usability can be explained by the positive affect evoked by the interface aesthetics.
- **Statistical Significance:** The ANOVA table confirms the model is a significant predictor of the outcome ($F(1, 158) = 68.826, p < 0.001$).
- **Coefficients:** The Unstandardized Coefficient ($B = 6.165$) suggests that for every one-unit increase in positive affect, the perceived usability score increases by approximately 6.17 points.

These statistical results provide robust empirical support for H4, confirming that a digital product prototype that evokes higher positive affect achieved significantly higher usability scores.

3.5. Descriptive Analysis of User Preferences And Aesthetic Ratings

Descriptive analysis of frequencies and central tendencies was conducted to evaluate H5 — that participants would rank highest the prototypes evoking the greatest positive affect.

Positive Colour was the most frequently preferred iteration, chosen by 43.1% ($N = 69$) of participants, followed by Positive Typography at 23.1% ($N = 37$). Collectively, positive valence iterations accounted for 76.8% of total preferences, against a significantly lower share for negative iterations. The mean preference score of 2.73 (median = 3.00) indicates a clear central tendency toward positive aesthetic clusters.

Individual ratings on the 5-point scale reinforced this pattern. Positive Colour achieved the highest overall mean ($M = 4.06, SD = 1.014$), with 41.9% of participants awarding it the maximum score of 5, while Negative Colour received a mean of just 2.37, with 41.9% assigning it the lowest score of 1. Positive Typography recorded a mean of 3.78, with 65% of participants rating it 4 or 5, compared to a mean of 2.76 for its negative counterpart. Whitespace showed the narrowest gap, with Positive Whitespace ($M = 3.18$) and Negative Whitespace ($M = 3.24$) receiving near-identical means, though 27.5% of participants still awarded the positive version a top rating of 5.

The data strongly supports H5. Positive aesthetic iterations were chosen as primary preferences at a rate exceeding 3-to-1 over negative ones, with participants consistently assigning higher numerical rankings to prototypes featuring positive colour and typography — confirming that the elements evoking the greatest positive affect are those most likely to be preferred and ranked highest.

3.6. Interpretation of Findings

The results support the Aesthetic-Usability Effect [27], demonstrating that manipulations of colour, typography, and whitespace profoundly shape both emotional affect and functional evaluation in human-computer interaction.

The significant main effect for valence ($p < 0.001$) confirms that positive design iterations evoke substantially higher affect than negative ones. Positive colour ($M = 4.06$) aligns with [28] and [31], whose work suggests that attractive colour triggers a top-down emotional response predisposing users toward more forgiving interaction. The strong preference for positive typography ($M = 3.78$) is consistent with [37], who established typography as a primary driver of mood and cognitive immersion. Whitespace showed a significant interaction effect but a narrower gap between positive and negative iterations, mirroring [23], who noted that whitespace's value is perceived subconsciously as an absence of clutter rather than an active aesthetic feature.

Regression analysis found that positive affect explains 30.3% of the variance in usability scores ($R^2 = 0.303, p < 0.001$), supporting the "What is Beautiful is Usable" phenomenon [28]. This is consistent with [41], whose participants rated a

visually appealing prototype as more usable and completed tasks more efficiently — a Halo Effect whereby aesthetic first impressions spill over into functional judgements [29]. The 76.8% preference for positive aesthetic clusters further supports [10], who identified initial attractiveness as the primary driver of early adoption. The gender-based difference — males reacting more punitively to negative aesthetics ($M = 39.28$) versus females ($M = 48.62$) — suggests aesthetic friction is a stronger deterrent for certain demographics, underscoring the need for inclusive design approaches [11].

4. Summary

The findings confirm that positive iterations of colour, typography, and whitespace produce significantly higher emotional affect than negative iterations. Colour achieved the highest mean rating overall and was the most frequently preferred element among participants, with typography closely following as a primary driver of emotional response. A significant positive correlation was found between aesthetic affect and perceived usability, and linear regression established that positive emotional affect is a meaningful predictor of usability scores. Gender analysis revealed that male participants showed more polarised reactions, rating positive prototypes higher and negative prototypes lower than female participants. Positive aesthetic iterations collectively accounted for 76.8% of total user preferences, and the high-fidelity positive prototype was statistically favoured over its negative counterpart by a substantial margin.

5. Conclusion

This research confirms that aesthetic elements are not peripheral to digital product design — they are functionally consequential. The study validates the Aesthetic-Usability Effect [27] and the Halo Effect [29], demonstrating that users are consistently predisposed to perceive visually appealing interfaces as more usable. Warm colours and legible typography were the strongest predictors of positive affect, while whitespace, though critical for perceived clarity, demonstrated a less immediate emotional impact, suggesting it operates as a more subjective component of the aesthetic experience. Taken together, the findings support the conclusion that a psychologically informed approach to design is a practical necessity: prioritising high-fidelity aesthetic variables reduces cognitive load, fosters user trust, and increases both the perceived usability and the overall success of a digital interface.

5.1. Implications

The results clarify a hierarchy within aesthetic processing — colour and typography produce more immediate visceral affect than whitespace — which validates Norman's three-level model of emotional design [31]. The ease of processing evoked by high-quality typography and colour appears to be misattributed by users as the system itself being more functional, a mechanism consistent with the concept of processing fluency.

Practically, these findings provide clear design priorities: colour schemes and typography should be treated as high-impact elements for building user trust, particularly in complex systems where some functional friction is unavoidable. A well-executed aesthetic layer can function as a psychological buffer, reducing the frustration users associate with inherent navigational difficulty. The gender-based differences in aesthetic sensitivity further suggest that demographic-specific testing would improve design outcomes in real-world applications [11].

In competitive markets such as Fintech or e-commerce, where credibility and perceived security are central concerns, these results carry direct commercial relevance. High-fidelity aesthetics serve as a non-verbal signal of professionalism; the positive affect evoked at first interaction can reduce bounce rates and lower a user's perceived risk, contributing to long-term retention and brand loyalty [17, 32].

5.2. Limitations

Several constraints should be noted. The sample, while statistically adequate, may not fully represent the global diversity of digital product users. All affect and usability measures relied on self-report, introducing subjectivity in the absence of biological or neurophysiological indicators. The prototype-based environment, though high-fidelity [48], is a simulation rather than a live product, which limits conclusions about how aesthetic impact evolves over extended real-world use. Finally, the interaction effects observed for whitespace suggest it is perceived more subjectively than colour or typography, making universal layout standards difficult to define.

Specifically:

- **Financial Interests:** The author has received no financial support, grants, or funding from any commercial or non-commercial organization for the conduct of this research.

- **Professional Relationships:** This research was conducted independently as part of the Master of Science in Clinical Psychology program at Kristu Jayanti College (Autonomous). There are no professional or personal affiliations with the developers of the design software or platforms mentioned in the study.
- **Authenticity of Data:** The data collected and analyzed in this study are original and have been gathered strictly for academic purposes.

Compliance with ethical standards

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Disclosure of conflict of interest

The author declares that there are no known conflict of interest or shared financial interests that could have appeared to influence the work reported in this dissertation.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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