



User Preferences for Icon Design Styles and Their Associations with Personality and Demographic

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Abstract. To gain a more comprehensive understanding of user preferences for icon design styles in different HCI interfaces, we investigated the associations between user preferences for icon design styles and the Big Five personality factors was investigated. 220 participants (100 males and 110 females) completed a questionnaire on icon design style preferences, personality traits, and background variables. The results showed that skeuomorphic and semi-skeuomorphic icons were more endorsed by those of higher age, and flat and semi-skeuomorphic icons were more endorsed by men than women. The remaining four personality factors (extraversion, agreeableness, conscientiousness, openness) and preferences for the three icon design styles were significantly correlated with each other, except for neuroticism. However, the correlations were low, indicating that user preferences for icon design styles are related to the user's personality traits or dimensions, and the correlation is low because there may be other factors that affect user preferences for icon design styles. It also indicates that these four personalities do not have aversive feelings toward icon styles. Overall, the results of the study confirm that icon design features are associated with user personality traits or dimensions and can help design appropriate icons and human-computer interaction interfaces to improve user satisfaction.

Keywords: Adaptive and Personalized interfaces · Icon design · Personality factors

1 Introduction

Human-computer interaction (HCI) is a knowledge and a multidisciplinary area that aggregates a vast and multifaceted community.

A current topic in the field of human-computer interaction (HCI) focuses on understanding and evaluating user-centered design, taking into account certain psychological factors related to the user's thought processes, feelings, and behaviors [1, 2].

Currently, most smart devices still use Graphical User Interface (GUI) as the main interaction interface mode. As one of the important components of the GUI interface, icons are widely used in action guidance, content differentiation, and status indication. They bear the important role of the carrier between the user and smart device interaction

interface. Some characteristics of icons are capable of exerting different effects on user performance [3, 4], appropriate icon design can add visual aesthetics to the project and enhance the brand image, and meet the personalized needs of the user experience.

Most current research on icon design styles has focused on two styles: skeuomorphic and flat. Skeuomorphic icons feature such as textures, shadows, and highlights to imitate real-world objects, aiding users in understanding the interface. In contrast flat icons can reflect better humanization. Confusion arises when their usage on mobile devices conflicts with the actual usage habits implied by the visual metaphor of the icon [5]. Thus, flat design highlights the content subject by removing gratuitous shadows, gradients, and textures, aligning with minimalism's primary goal. However, it may also encounter readability issues and consequently be misused by users [6]. With the prevalence and improvement of icon design, the boundary between skeuomorphic and flat design has gradually blurred. In recent practice, a combination of skeuomorphic and flat designs has been used. The study by Kairu Zhao et al. [7] refers to this style as the semi-skeuomorphic style. A typical example is Google's material design language "flat 2.0". In contrast to the heavy texture of the skeuomorphic design, it is a lighter texture, with appropriate embellishments without disturbing the content. Compared to flat design, skeuomorphic design features a soft texture and innovative appearance, rendering such icons look more realistic, modern, futuristic, and attractive. However, it also has the disadvantages of poor visibility, low recognition, and reliance on the background color.

As an important element in the human-computer interaction interface, icons have been widely studied by scholars focusing on aesthetics and user experience. For instance, Luo, S.J et al. [8] analyzed the influence of icon background shapes and figure/ background area ratios on visual search performance and user preference. Xiaoming Zhang et al. [9] studied the influence of application icons on user experience and summarized the key factors affecting user experience in four dimensions including identification accuracy, cognitive validity, and degree of emotional arousal as well as emotional validity of icons. Ruoyu Chen et al. [10] explored the extent to which users can perceive the difference between icons designed in skeuomorphic and flat icons, and investigated how the design style affects visual search performance across different age groups.

Due to individuals' diverse cultural, psychological, and physiological backgrounds during interface interaction [11], designers are encouraged to develop intuitive availability, aligning with users' expectations when engaging with artifacts. The design interventions tested by Oded et al.'s [12] have been demonstrated to exert varying effects on individuals with different levels of personality traits, thereby elucidating the potential value of personality-oriented design. However, the integration of individual personality traits, which vary among users, has yet to be fully implemented in UI design. Linking UI design features to users' personality traits or dimensions can enhance users' ability to process and comprehend visual information effectively, thereby facilitating their interaction with the interface [13]. Samer Muthana Sarsam et al.'s [13] study indicates that certain personality dimensions can be used to increase user satisfaction with interface design, and users' attention may be influenced by the type of design elements placed in the UI based on their personality profile, potentially impacting the efficiency of their information processing. This may potentially affect the efficiency of their information processing. When UI design is shaped according to the user's personality profile, it

may affect the overall interaction experience generated through the close integration of visual information with other cognitive modalities to stimulate the visual system. Fuchs-Frohnhofer et al. [14] suggested that “an important aspect of human-centered system design is cognitive compatibility, which means that the structure of the human-machine interface of the computer should match the cognitive styles of the users.” Given the aforementioned research perspective, this study was motivated by preferences for icon design styles and their associations with personality. Considering that various individual differences, including age, gender, job roles, language, culture, and fundamental idiosyncratic attributes, may influence technology [15], we incorporated demographics as variables.

Basic demographics are considered to be influential factors in user preference for icon style, with younger people preferring flat icons aesthetically. In contrast, older people aesthetically appreciate skeuomorphic icons more [10]. Younger people are more likely to understand most icons compared to older people [11]. Therefore, older people are less confident in interpreting icons. The skeuomorphic icon usually highly mimics the real world and it is less difficult to interpret Skeuomorphic icons than flat icons that are abstract, minimalistic, and symbolic for users, so this may be the reason why older people prefer skeuomorphic icons.

Personality is considered to be an individual’s unique variation in the general evolutionary design of human nature. It is expressed as a developmental pattern of dispositional traits, characteristic adaptations, and self-defined life narratives. These elements are complexly and differentially situated in culture and social context [17]. Over the past century, as a result of continuous research on personality, many taxonomies of personality traits have been proposed. Eysenck, H. J. [18] proposed a “three-factor model” that divides personality traits into three factors: extraversion, neuroticism, and psychoticism. Alpert proposed the Theory of Personality Traits, which divided personality traits into common traits and individual traits, and differentiated them into three overlapping levels according to their different influences and effects on personality: primary traits, important traits, and secondary traits. Cattell et al. [19] used factor analysis to propose 16 mutually independent root traits and compiled the Cattell 16 Personality Factor Test (16PF). Analytical studies of these numerous personality models have revealed that the number of factors they include and the nature of the factors varies widely with little consistency. Currently, the personality trait classification that has received the most attention and support from personality researchers is the five-factor model [20]. It has been confirmed by research in several fields that the Big Five factors are relevant and valid dimensions of personality that reliably predict differences between individuals and are considered by many psychologists to be the best paradigm for personality structure. The model provides a comprehensive overview of five dimensions of personality, each containing specific traits; neuroticism, the presence of traits that make it difficult to balance emotions such as anxiety, hostility, repression, self-consciousness, impulsivity, and vulnerability, i.e., the inability to maintain emotional stability; conscientiousness, the presence of traits that show competence, fairness, organization, dutifulness, achievement, self-discipline prudence, and restraint; agreeableness, with traits such as trust, altruism, straightforwardness, compliance, humility, and empathy; openness, with traits

such as imagination, aesthetics, emotional richness, dissimulation, creativity, and intelligence; and extraversion, showing traits such as enthusiasm, socialization, decisiveness, activity, risk-taking, and optimism [21].

There is no sufficient research to explain the relationship between user personality and preferences for icon design styles included in interfaces, so in this study, we will investigate whether different personality traits affect user preference for icon design styles.

The results of the study will help create guidelines for personalized interface design that depends on user psychological variables. This guide serves a dual purpose: firstly, aiding designers in identifying the types of users likely to be attracted to their icon designs; secondly, assisting designers in evaluating whether their icons are tailored to the intended target audience or need refinement to align with user personality traits, thereby enhancing user experience and reinforcing brand image.

2 Method

2.1 Participants

The study sample consisted of 210 smartphone users (100 men and 110 women) from different geographical regions of China, ranging in age from 18 to 60 years ($M = 31$, $SD = 12$), of which, 40% were married and 60% were unmarried. All the participants were volunteered and gave their informed consent to take part in the study.

2.2 Procedure and Instruments

Subjects were asked to complete a packet of three questionnaires in the following order: preference evaluation, the 40-item brief version of the Chinese Big Five Personality Inventory (CBF-PI-B), and the Background Data Inventory. It took approximately 8 min to complete all questionnaires. A total of 233 questionnaires were returned, and after eliminating invalid responses, a total sample size of 210 valid questionnaires was obtained.

The design of the preference evaluation test is as follows. First, we collected 16 commonly used functions from smartphone and web interfaces: camera, photo album, calendar, clock, calculator, browser, settings, music, calculator, flashlight, mailbox, address book, memo, map, wallet, and stock market corresponding to three styles (flat design, skeuomorphic design, and skeuomorphic design) of icons (48 in total). Participants were presented with a randomly disorganized list of 48 icons with functional descriptions on the right side of each icon, and participants were asked to rate their preference for liking each icon design on a scale of 1–5, with 1 indicating extreme dislike and 5 indicating extreme like (see Fig. 1). The results of participants' ratings were collected, and the 16 scores of participants for each of the three design style icons were summed to obtain the preference scores for each of the three styles, and statistical analysis was performed in SPSS.

The Chinese Big Five Personality Questionnaire Brief Version (CBF-PI-B) [22–24] consists of 40 entries to assess five personality constructs. The questionnaire is a personality questionnaire developed to fit Chinese people's verbal expression habits using



Fig. 1. A figure caption is always placed below the illustration. Short captions are centered, while long ones are justified. The macro button chooses the correct format automatically.

the Big Five model as a theoretical framework and assesses five dimensions of personality traits: Neuroticism, Conscientiousness, Agreeableness, Openness, and Extraversion. Zhang X et al. [24] study provided initial support for the utility of the CBF-PI-B by showing good factor structure, acceptable internal consistency reliability, and, as expected, convergent, discriminant, and criterion-related validity. The components of the questionnaire were as follows: Neuroticism (8 items; e.g., "I am often afraid"); Conscientiousness (8 items; e.g., "Once I set a goal, I stick to it and work hard to achieve it"); and Agreeableness (8 items; e.g. "I think most people are basically well-intentioned"); Openness (8 items; e.g., "My mind is often full of vivid images"); Extroversion (8 items; e.g., "At lively gatherings, I often take the initiative and have fun at lively parties"). In the current study, Cronbach's alpha coefficient was 0.81 for Neuroticism, 0.81 for rigor, 0.76 for Agreeableness, 0.78 for Openness, and 0.80 for Extraversion. The participants were asked to make a choice based on the degree to which each sentence matched their personality, with seven reverse scored entries, specifically: 5, 8, 13, 15, 18, 32, and 36. The reverse questions were the first reverse scored, and then each dimensional question was summed to obtain the five-dimensional scores.

The demographics were collected through a questionnaire that asked participants to indicate their gender, age, geographic location, marital status, and education level.

3 Results

3.1 User Preferences for Icon Design Styles and Sociodemographic Factors

A one-way ANOVA was conducted to examine the differences in preference for icon design styles between men and women. ANOVAs conducted for each icon design style indicated significant gender differences in all four styles: ANOVAs were conducted for the scores related to user preferences for icon design styles, and the results showed significant gender differences in the flat and skeuomorphic design: flat icons, $F(1, 208) = 6.898, p < 0.01, \eta^2 = 0.032$; skeuomorphic icons, $F(1, 208) = 5.298, p < 0.05, \eta^2 = 0.025$. Scores presenting female preference for flat icons ($M = 52.45, SD =$

9.741) and preference for semi- skeuomorphic icons ($M = 53.54$ $SD = 9.89$) were lower than men ($M = 52.58$, $SD = 9.70$; $M = 53.67$, $SD = 9.85$ for flat and semi- skeuomorphic icons, respectively).

We next tested the association between the preferences for three icon design styles and age using Pearson correlations. User preferences for flat icons $R(209) = -0.242$, $p = 0.000$, user preferences for semi- skeuomorphic icons $R(209) = 0.275$, $p = 0.000$, user preferences for skeuomorphic icons $R(209) = 0.402$, $p = 0.000$. This indicates that higher age is positively correlated with higher preference for the semi- skeuomorphic and skeuomorphic icons and negatively correlated with higher preference for the flat icons.

3.2 User Preferences for Icon Design Styles and Personality

Pearson correlations between user preferences for icon design styles and personality were calculated and the results are shown in Table 1, which shows that all factors except Neuroticism were significantly and positively correlated with higher preference for flat and skeuomorphic icons, but the correlation with skeuomorphic icons was stronger. The three factors extroversion, Agreeableness, and Openness were significantly and positively correlated with higher preference for semi- skeuomorphic and skeuomorphic icons, but the correlation was weaker. Conscientiousness was significantly and positively correlated with higher preference for semi- skeuomorphic icons with a moderate correlation.

Table 1. Pearson correlations between preference for icon design styles and the Big Five personality dimensions.

	Preference for icon design styles		
	Flat	Semi- skeuomorphic	Skeuomorphic
Extraversion	0.185**	0.214**	0.317**
Agreeableness	0.185**	0.259**	0.339**
Conscientiousness	0.341**	0.439**	0.456**
Neuroticism	−0.086	−0.083	−0.068
Openness	0.283**	0.259**	0.300**

Note. ** $p < 0.01$

3.3 The Contribution of Demographic and Personality Factors to User Preferences for Icon Design Styles

A series of two hierarchical regressions were conducted to examine the unique and combined contribution of each study variable to the explained variance of the three icon design styles, with variables entered in a forced order in the regression analysis; socio-demographic variables (gender, age, education) in step 1; personality factors were added

in step 2, and interactions between variables were added in step 3, using a stepwise approach so that only interactions showing significant interactions that showed significant contributions were entered into the equation. The results are shown in Table 2.

Table 2. Hierarchical regression coefficients (beta weights) for the prediction of user preferences for icon design.

	Preference for icon design		
	Flat	Semi- skeuomorphic	Skeuomorphic
Step 1			
Gender	17.906	29.160*	18.073
Age	−1.903***	−0.962	−0.246
Education	−4.752	5.298	−6.770
ΔR^2	0.068**	0.076***	0.162***
Step 2			
Openness	0.10	0.484	−1.497
Neuroticism	0.126	1.069*	0.933
Conscientiousness	0.278	0.854	1.383
Agreeableness	−0.003	0.146	0.230
Extraversion	−1.707*	−1.884*	−0.345
ΔR^2	0.095***	0.141***	0.138***
Step 3			
Openness x Gender	0.031	−0.269	0.111
Openness x Age	0.008	0.001	0.030
Openness x Education	−0.089	−0.171	0.259
Neuroticism x Gender	−0.364	−0.585	−0.179
Neuroticism x Age	0.015	0.007	0.005
Neuroticism x Education	−0.232	−0.490*	−0.400
Conscientiousness x Gender	−0.202	−0.040	−0.096
Conscientiousness x Age	0.011	0.003	−0.009
Conscientiousness x Education	−0.059	−0.181	−0.275
Agreeableness x Gender	−0.355	−0.359	−0.607*
Agreeableness x Age	0.004	−0.004	−0.012
Agreeableness x Education	0.067	0.119	0.319

(continued)

Table 2. (continued)

	Preference for icon design		
	Flat	Semi- skeuomorphic	Skeuomorphic
Extraversion x Gender	0.328	0.348	0.267
Extraversion x Age	0.024	0.027*	0.002
Extraversion x Education	0.369	0.450	0.173
ΔR^2	0.144**	0.139***	0.078
R^2	0.307***	0.378***	0.356***

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

As shown in Table 2, the independent variables explained a total of 9.5% of the variance in preferences for flat icons, a total of 14.0% of the variance in preferences for semi- skeuomorphic icons, and a total of 13.8% of the variance in preferences for semi-skeuomorphic icons.

In the analysis of preferences for flat icons, a significant contribution of age was found in step 1, indicating that younger people prefer flat icons over older people, and a significant contribution of extraversion was found in step 2, where people with high extraversion have a lower preference for flat icons.

In the analysis of preferences for semi- skeuomorphic icons, gender played a significant role in Step 1, indicating that women preferred the semi- skeuomorphic icons over men, and significant contributions of neuroticism and extraversion were found in Step 2, indicating that higher neuroticism and lower extraversion had higher preferences for the semi- skeuomorphic icons, and two significant interactions emerged in Step 3: neuroticism and education, extraversion and age.

Simple slope analyses were conducted to examine the source of these interactions, and the results are shown in Fig. 2. The analysis showed that higher neuroticism was significantly correlated with decreased preference for semi-skeuomorphic icons among the users with higher levels of education, $b = -0.458$, $p = 0.001$; but not among their less educated counters, $b = 0.243$, $p = 0.085$. Thus, users with higher levels of education and less Neuroticism may prefer semi-skeuomorphic icons. Users with higher Extraversion are significantly associated with increased preferences for semi-skeuomorphic icons among older users, $B = 0.475$, $p = 0.000$, but not among younger users, $B = -0.035$, $p = 0.789$. In other words, users who are older and more characterized by Extraversion may prefer semi-skeuomorphic icons.

No significant contribution was found in step 1, step 2, and step 3.

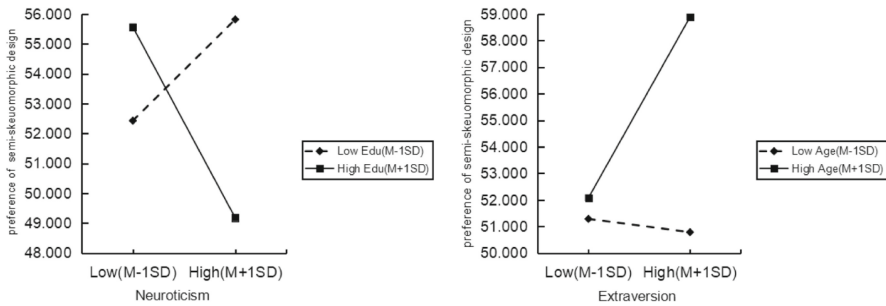


Fig. 2. Neuroticism x Education preference of semi-skeuomorphic design and Extraversion x Age preference of semi-skeuomorphic design.

4 Discussion

The present study aims to enhance understanding of factors associated with user preferences for three iconographic design styles: flat design, semi-skeuomorphic design, and skeuomorphic design. In order to provide as comprehensive a description as possible, personality, as well as basic demographics, were examined. This finding is consistent with previous research indicating that preferences for icon design styles differed between higher and lower ages, with higher preferences for skeuomorphic and semi-skeuomorphic icons at higher ages [8]. It was also found that gender could also be a basic predictor, with men exhibiting higher preferences for flat and semi-skeuomorphic icons compared to women.

In our study of personality factors, we found that, except for Neuroticism, the remaining four personality factors (Extraversion, Agreeableness, Conscientiousness, and Openness) were significantly correlated with user preferences for the three icon design styles ($p < 0.01$). However, the correlation was low, indicating that the user preferences for the icon styles were correlated with the user's personality traits or dimensions. Owing to the possibility of other factors affecting user preferences for icon design styles, the correlation values remain consistently low. Additionally, the correlation values of these four personality factors with user preferences for the three design styles were all positive. This suggests that individuals with these personality traits do not exhibit aversive emotions towards the three types of icons.

If we consider all the factors that uniquely contribute to user preferences for icon design styles, we find that flat icons are supported by the younger and people with less Extraversion. Semi-skeuomorphic icons are endorsed to a higher degree by men and middle-aged and older people. In the judgment regarding preferences for semi-skeuomorphic icons, for users with higher levels of education, it can be predicted by lower Neuroticism. On the other hand, for users of older age, it can be predicted by higher Extraversion.

The current study is the first attempt to integrate demographic and personality factors in order to gain a more comprehensive understanding of the factors influencing preference for the three icon design styles.

However, it is crucial to acknowledge several limitations of the study. Despite efforts to diversify the sample by including individuals from various age groups and geographic regions, a significant proportion of participants possessed high levels of education. While education was not found to be directly related to the three icon design styles, the findings do suggest potential differences between individuals with varying levels of education due to interaction effects. Therefore, employing a representative sample would be advantageous for outcome measures in future studies. Second, the non-significant results due to multiple tests suggest that many of the relationships are unexplained. Therefore, other independent variables not currently considered may help to better explain the reasons for preferences for different icon design styles.

Despite the limitations of the study, the current findings suggest that a multidimensional and holistic approach is necessary when related to drivers. Design approaches that consider the diverse personality traits and background variables of smart device users are more effective than unidimensional strategies.

A quantitative analysis of icon design styles can effectively address interface usability issues and provide valuable insights for designers in developing icons for smart device human-computer interaction interfaces, including those of computers, cell phones, and navigation systems. By considering various interface design elements such as color, layout, typography, and font size, alongside icon design style, future research can comprehensively explore their potential intrinsic connections with users' personality traits. This exploration aims to identify interface design elements that significantly influence user preferences and to develop design guidelines conducive to interface optimization. Through iterative refinement of these design elements, interfaces can be tailored to be more personalized, user-centric, reasonable, and conducive to enhancing the overall user experience and brand perception.

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