Skeuomorph Versus Flat Design: User Experience and Age-Related Preferences

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Abstract. The "right" design of graphical user interfaces (GUI) may help to provide positive user experience and to support users in dealing with the complexity of technological artifacts. We compared two design strategies for GUIs: skeuomorph and flat design. For this purpose, two interface versions of a smart phone operating system (flat and skeuomorph) were created. Since skeuomorph design uses metaphors from the non-digital world, we expected that it is preferred by elderly users (digital immigrants) compared to young users who might choose the modern flat design (digital natives). To test this assumption, we conducted a study ($N = 24$) with younger and elderly users by combining a standardized usability testing scenario, a user experience questionnaire (meCUE), and a half-standardized interview. Our results indicate that there is a significant difference between the two age groups. Elderly users showed a preference for skeuomorph design whereas the younger generation favored the flat design. Practical consequences and theoretical implications of these findings are discussed on the basis of the CUE model (Components of User Experience).

Keywords: Skeuomorph design · Flat design · User experience
CUE model · Hygienic and motivational factors
Graphical user interfaces (GUIs) · Preferences · Age

1 Introduction

Digitization has changed our daily life more than any other technological or industrial revolution before. The digital world becomes increasingly complex and humans are often confronted with straining systems they cannot fully understand. Therefore, designers are striving to improve user experience (UX) and to reduce complexity by creating interfaces that are easy to comprehend und intuitive to use. Adherents of two opposite design strategies argue about what is the "better design" to reach that goal: skeuomorph or flat [1]. As will be shown in the following, both strategies have a number of assets and drawbacks.

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1.1 Skeuomorph Versus Flat Design

The term **skeuomorph** is derived from the Greek words *skeuo* (container or tool) and *morph* (shape or gestalt) and originated from the arts and crafts [2, 3]. Skeuomorph design can be characterized as adding features and properties to digital products or artifacts that are not necessary for their functionality [4], e.g. faux-wooden bookshelves in iBooks (iOS 6). Skeuomorph design transfers characteristics of objects from the physical world into the digital GUI [5] to generate a feeling of familiarity and to increase the perceived value of products [6]. If one knows an item from the real world, one might interact faster and more intuitively with its counterpart in the digital world. Skeuomorphism goes in hand with a more realistic design and uses metaphors and affordances. Therefore, it is often considered as self-explanatory and easy to use [7], and it has been shown to improve the hedonic quality of products [4]. Adding unnecessary aspects, however, may lead to cluttering and thus increase users' cognitive and visual load as well as the loading time of the device – both reducing its usability. Furthermore, some researchers argue that the advantage of the real-world metaphor may not work for younger generations of 'digital natives' as they are not familiar with the real-world archetypes [8], such as the floppy disk serving as a symbol for saving files.

Flat design can be seen as the counterpart of skeuomorphism. Flattening GUIs means to refrain from real world elements [5, 9]. The success of flat design started with the revolutionary redesign of operating systems (OS), e.g. Microsoft 8 and Apple iOS 7 [10–12], where the interface was reduced to the essential. 3D effects, shadows, lights, texture, and many other non-functional features were removed. Flat design "emphasizes a minimalist design language of flat colors and an overall digital-native mentality" [10, p. 4]. This minimalistic approach has a lot of advantages with respect to loading times [13]. Furthermore, it is mostly regarded as clean and pure [11] following the less-is-more zeitgeist and, doing so, fostering consistency in visual design [13]. Anyhow, users from an older generation are not that familiar with flat designs and may miss the metaphors and affordances they got accustomed to.

As these arguments show, the pros and cons for each design strategy might be related to the user's age. Therefore, elderly users may have other design preferences than younger users and may experience both design strategies differently.

1.2 Design and User Experience

UX is closely linked to design aspects because it involves "a person's perceptions and responses that result from the use or anticipated use of a product, system or service" [14]. Hence, UX comprises two important factors, the perception of non-instrumental qualities, (such as visual aesthetics, haptic quality, identification, or stimulation), and the perception of instrumental qualities (like usability, functionality or usefulness) [15–17]. The interaction of these different aspects is illustrated by a number of models in UX research, such as the Components of User Experience model (CUE model, see Fig. 1; [15, 18, 19]). The CUE model describes UX as the result of interaction characteristics that are impacted by system properties, user characteristics, tasks, and the context of use. With respect to the present study, it must be noted that the model does not regard the user's age as a factor of influence per se. Instead, individual features,

such as knowledge, attitudes and habits that are typical for users of a particular age or generation are considered to impact the usage of a system. The resulting interaction characteristics frame the user's perception of non-instrumental (hedonic) qualities and instrumental (pragmatic) qualities. Both perceptions are closely linked to emotional reactions during the interaction with the artifact, and together these three components impact the overall judgment of the system and its future usage (or non-usage).

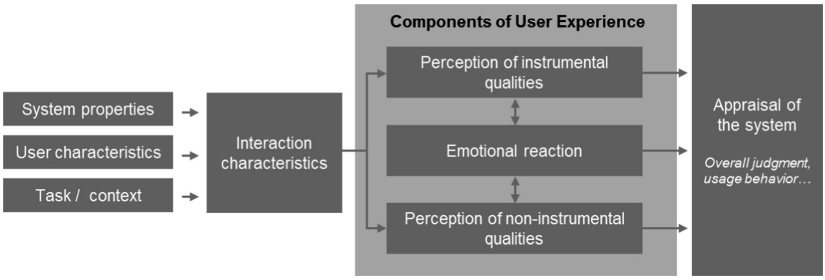

Fig. 1. CUE model (based on [15, 18, 19]).

All three UX components can be linked to the two design strategies. The perception of visual aesthetics, for instance, is an important aspect for both, flat and skeuomorph design. Do users prefer a minimalistic style ('less is beautiful') or do they appreciate ornaments and décor? Depending on their liking and prior experience, users' aesthetic impressions may be different for the two designs. As to pragmatic qualities, users might perceive a skeuomorph interface as cluttered since the data-ink ratio is much smaller compared to a flat one [20]. Consequently, the minimalistic approach might have advantages for usability and efficiency [21]. Flat design, however, may lead to a loss of information that users value and regard as helpful [13]. Moreover, it refrains from 3D shapes and is therefore less affordant [1]. Since affordances make controls more self-explaining and support their intuitive usage, they can improve users' interaction with a system [22–24]. Emotional reactions might also differ for the two design styles: Familiar items from the real world might be linked to memories and therefore elicit emotions during the interaction [20, 25]. Furthermore, a physical look-and feel can be stimulating and therefore may be considered as aesthetically pleasing [26]. Again, there are pros and cons for both design strategies and each may have advantages as well as disadvantages for the generation of positive UX.

2 Related Work

In response to the shift from skeuomorph to flat design, the implications of both design strategies for UX and HCI have been studied in different contexts, e.g. for the design of operating systems and websites, with respect to automotive assistance systems, as well as for symbols and icons in general.

2.1 Empirical Comparison of Skeuomorph and Flat Design in UX

Several researchers tested the effect of skeuomorph and flat design in the context of mobile operating systems. Oswald and Kolb [7] conducted a survey immediately after the preview of Apples release of iOS7 in June 2013 in order to capture the initial responses to the paradigmatic shift from skeuomorph to flat design. A relatively young sample (M = 27 years) of smart phone users (91%) had to compare iOS6 (skeuomorph) and iOS7 (flat). The flat design was rated as more fun and childlike whereas the skeuomorph design was rated as more serious and grown-up. In a follow-up study eight months after the first sample, the authors observed a change of judgment. The "new", flat design was now rated similar to the "old", skeuomorph design. The initial difference was interpreted as a "novelty effect", which resulted from comparing a radical new design to an established design that had been around for a long time. This effect, however, vanished after the participants got used to the change. Schneidermeier and colleagues [11] conducted a study to compare Windows 7 (skeuomorph) and 8 (flat, metro design) with respect to usability (i.e., effectiveness, efficiency and user satisfaction). Windows 7 performed better in terms of effectiveness (task success score), efficiency (number of clicks and completion time), and overall satisfaction. However, the authors conclude that this effect might vanish with growing experience and exposure to the flat interaction style, which is in line with the results of the study by Oswald and Kolb [7].

In summary, both studies show how former experience with design features and systems can influence the experience and subjective usability of common users. But how do experts, especially designers, value the skeuomorph and flat strategy? Page [27] surveyed 274 design students about their preferences for using them in practice and found that the majority favored the minimalistic approach. However, they also saw a benefit in combining both. This combination is named "skeuominimalism" and "provides a methodology for the development of learning objects in mobile design education" [27, p. 131].

Such a combination was applied by Wu and colleagues [5]. They designed three versions of an interface for a navigation system: one strictly skeuomorph, another strictly flat, and a third one "skeuominimalistic" as a combination of both. Forty-five students interacted with all versions of the interface in the laboratory. Emotions, UX and the perceived artificiality of the design were assessed with respective questionnaires. While the skeuomorph version received the lowest UX ratings and artificiality judgments, the moderate version was rated highest and the flat version ranked second. Moreover, the two rating scales correlated strongly with each other (r = .8). According to the authors, artificiality had a large significant positive effect on judging UX. The flat design which was considered as more artificial led to a higher UX rating in contrast to the skeuomorph design. However, the study used a rather young sample (M = 23.67, range 20–27 years) what might have influenced the strong preference for the moderate respectively flat design version of the interface.

Differences between skeuomorph and flat design have also been shown for visual search. In an eye-tracking study [28], several icon types were compared (line-drawing, metro, flat, and skeuomorph design). Skeuomorph design showed the longest average total task time and the longest time to first fixation as well as the longest average

fixation duration and the highest average visit frequency. The authors conclude that there is a relationship between visual complexity and search efficiency. The more complex the icon design, the longer it took the participants to find the correct item. Skeuomorph design was by far the least efficient design strategy in this study.

Pelet and Taieb [21] evaluated the layout of a mobile ecommerce website. Results showed that the flat layout led to higher ease-of-use and intention-to-use ratings. In addition, users of the flat interface were more willing to order something as well as to revisit and recommend the site. However, the authors conceded that more research has to be conducted regarding preferences of the ageing population in order to make internet applications universally acceptable.

Li, Shi, Huang, and Chen [25] analyzed the difference between the two design strategies by comparing flat and skeuomorph symbols for graphical user interfaces. The authors discuss advantages and disadvantages for both, skeuomorphism and flat design. On the one hand, skeuomorph symbols are more familiar to users and thus enable them to infer the represented functions faster and more easily. On the other hand, they are shaped by the culture they come from, making it hard for users with a different cultural background to understand their meaning. Moreover, skeuomorph symbols tend to be rather complex which may lead to overloaded and unclear interfaces. However, the authors also argue that flatly designed symbols can "escape their function" if they are too planar. They conclude that skeuomorphism has social significance and is related to personality and emotions. It enables unique experiences, but is also complex and culturally biased.

2.2 Design Preferences and Age

An important factor for the UX of different GUIs seems to be the user's age. The term *Digital Natives* was coined by Prensky [29] in 2001. He described a new generation that grew up in the digital world of modern information and communication technologies, like smart phones and computer games. On the opposite, previous age groups were described as *Digital Immigrants*. Their analogue selves had to adapt to the digital world due to social pressure or changes in their working environment (e.g., with the advent of personal computers) [7]. However, Digital Immigrants grew up with analogue technologies, like telephones with keypads or even rotary dials. They remember how it felt to lift the receiver to answer a phone call, and they used floppy disks to save and exchange digital data files [30]. As metaphors referring to the analogue era, the appearance of such devices is transferred into the digital age by the symbolic language of skeuomorph interface design.

Cho and colleagues [31] analyzed the impact of skeuomorph app icons on elderly users. A conjoint analysis showed that a higher degree of realism increased the aesthetic satisfaction and improved the understanding of the icons in this age group. The advantage was even bigger for novice users among the elderly. The results indicate that the experience with analogue counterparts of digital app icons augments the acceptance of the technology and the comprehension of the underlying functions. These findings are in line with the results of an investigation by Blaynee and colleagues [32]. The authors conducted a UX diary study with 25 elderly participants (age $\geq$ 65 years) and concluded that skeuomorphism was a way to enable older persons to relate to the

design. They argued that the shift to flat design makes it harder for the elderly to access digital technologies since affordances are removed and the familiarity with analogue technology is impaired.

The effect of flat icons on elderly users was also tested by Sha et al. [33]. In an experimental study, 24 participants (age $\geq$ 60 years) had to recognize icons in a visual search task and were asked to report their satisfaction with them. The icons were all flat but differed in color. They were either multi-colored or monochromatic. The task consisted of the presentation of a target icon and its recognition after a short interval. The two color conditions significantly influenced the required time for recognition: the monochromatic items were identified more quickly. The subjective data revealed that monochromatic items were rated as more concise, easier to remember, but less beautiful. Even though the study used flat icons only, it emphasizes the importance of UX in this context. It shows that perceptions of instrumental and non-instrumental qualities are neither always in line with each other, nor are they necessarily affected in the same manner. Taken together, the studies by Cho et al. [31] and Blaynee et al. [32] show that elderly users tend to prefer the skeuomorph design, as it increases satisfaction and improves the perceived non-instrumental qualities. However, Sha et al.'s [33] results indicate, that superfluous information (e.g. multi-coloring of icons) can impair the instrumental qualities of a device.

Although the three studies provide a valuable gain of knowledge, they have a shortcoming. They are restricted to elderly persons and lack the comparison with other age groups (younger users, respectively *Digital Natives*). Such a comparison was made by Robbins [34], who studied the preferences for flat and skeuomorph design in three age groups (younger: 13–26, middle: 27–45, old: 46 and older). While he found a preference shift for the middle agers towards flat design, both the younger and older groups were almost evenly distributed on the two design strategies. However, the results were only reported descriptively without testing for significant differences. Furthermore, the study did not look at the underlying mechanisms that might have led to the preferences of the age groups. Zhang and colleagues [26] also used an experimental approach to compare skeuomorph and flat designed icons. Over all participants, there was a slight preference for skeuomorphism. Again, an age effect could be obtained. Adults (age > 30 years) and children (age < 15 years) showed a tendency towards skeuomorphism, whereas participants in the medium age category (15 $\geq$ age $\geq$ 30 years) showed a preference for flat design. However, the differentiation between the age groups appears as questionable in both studies since they only investigated rather young samples.

Summing up, it seems that the preference for a GUI is influenced by age-related user characteristics and the design strategy. Elderly users are often less familiar with modern technologies and more accustomed to the original archetypes that are metaphorically used in skeuomorph design. The younger generation, in contrast, might not be that familiar with skeuomorph design elements [8] and seems to appreciate minimalistic GUIs in a flat style. According to the CUE model, differences in preferring one design type over the other should be rooted in differences of the UX between the two age groups. Hence, an interaction effect of age (young vs. old) and design (skeuomorph vs. flat) should occur in an experiment which investigates preferences as well as components of UX.

3 Empirical Study

To test the interaction hypothesis, an experiment with a mixed-methods approach was conducted in which both age groups (young vs. old) and two design strategies (flat vs. skeuomorph) served as independent variables. In case of an interaction effect, the younger group should prefer the flat design while the older group should favor the skeuomorph design. Moreover, differences for perceived instrumental qualities (usability, usefulness), non-instrumental qualities (aesthetics, status) as well as emotions (positive, negative) should occur that are in line with the respective preferences.

3.1 Participants

$N = 24$ persons participated in the study[1]. All of them were assigned to one of two groups according to their age. All members of the "young" group had used a personal computer regularly before the age of eighteen ("*digital natives*" [29]). Each group consisted of twelve participants. The demographic structure is presented in Table 1. Participants received no gratification for taking part in the experiment.

Table 1. Demographic structure of the sample (*M* – Mean, *SD* – Standard Deviation)

Group	Sample *N*	Gender N_{Male}/N_{Female}	Age *M* (*SD*)
Young	12	6/6	24 (*3.30*)
Elderly	12	6/6	50 (*10.78*)
Total	24	12/12	37 (*15.23*)

3.2 Material

Versions. Two high-fidelity versions of a smart phone OS were especially designed for the study using Axure RP Pro. They were presented on a Samsung Galaxy S4 smart phone. Each version showed eighteen typical apps on its home screen; six of them were functional for user testing (weather forecast, notes, contacts, documents, alarm clock and settings). The versions were equipped with the same functionality, but differed in design (skeuomorph vs. flat, see Fig. 2).

UX Questionnaire. To assess the UX variables, six scales of the German version of the meCUE questionnaire ([36], see also http://www.mecue.de) were used: usability, usefulness, aesthetics, status, positive emotions, negative emotions. Each scale consists of three items (except for positive and negative emotions with six items). All items employ a bipolar seven-point-Likert scale ranging from "strongly disagree" (1) to "strongly agree" (7). The scales are theoretically based on the CUE-model (see Fig. 1)

[1] According to [35] with a sample size of $N > 23$ participants large effects ($\eta_p^2 \geq .14$) can be found with a power of $1-\beta = 0.9$ (for $\alpha < .05$, two-tailed).

and the items used in this study are listed in the appendix (German and English version, see Table 3).

Fig. 2. Exemplary Screenshots of the Smart Phone OS Versions (left side: flat, right side: skeuomorph).

Paper-Based Stimuli. To assess the general preference for flat or skeuomorph design, the following materials were created and printed on cardboard or paper: (a) eleven pairs of icons (taken from the flat and skeuomorph version in Fig. 2), (b) a screenshot of each complete GUI (see also Fig. 2), and (c) 23 positive attributes, such as 'precious', 'stylish', 'professional', 'novel', etc. (adopted from [16]). The cardboard icons and OS versions served to inspire verbal responses in the qualitative interview at the end of the experiment.

3.3 Procedure

After filling in a consent form and questionnaires for assessing demographics, technological experience, and personal innovativeness (as control variables), participants completed a number of tasks embedded in a typical usage scenario (calling a friend, finding and opening a file, making notes, setting the alarm). All tasks were accomplished with both, the flat and the skeuomorph OS version on the smart phone. The order of tasks was counterbalanced over all participants and blocked for each version. During the interaction, the screen was recorded and participants' verbal comments were taped. After the tasks, everyone filled in the meCUE questionnaire for each version. Then the screenshots on cardboard were presented and the participants were asked which one they would like to use more often (design preference). Subsequently, the printed app icon pairs were shown and everybody had to select one icon of each pair (flat vs. skeuomorph) to indicate his or her preference. Finally, the verbal attributes had to be assigned to one of the two screenshots. The selected icons and attributes were

discussed with the interviewer in a half-standardized interview to investigate the reasons for the preferences. The whole study lasted approximately one hour.

3.4 Experimental Design and Statistical Analysis

The two independent variables were represented by the factors "design strategy" (flat vs. skeuomorph, within subjects) and "age" (elderly vs. young, between subjects). The combination of both factors resulted in a mixed *2 x 2* experimental design. Since only interaction effects were expected (see Sect. 2.2), we focus on the interaction effect of both factors but also analyze the main effects in a *2 x 2* mixed ANOVA for the dependent variables (i.e., the UX scales of the meCUE questionnaire). *F*- and *p*-Values are reported for significant differences, the effect size is quantified by partial eta squared (η_p^2). According to [35], $.01 \leq \eta_p^2 < .06$ corresponds to small, $.06 \leq \eta_p^2 < .14$ to medium, and $\eta_p^2 \geq .14$ to large effects.

The preference for one of the designs was a dichotomous (binary) dependent variable which can be represented in a *2 x 2* contingency table ("age" x "preference"). We analyzed it with Fisher's exact test and report *p*-Values and the Odds Ratio (*OR*) as effect size. According to [37], $1.5 \leq OR < 3.5$ corresponds to small, $3.5 \leq OR < 5.0$ to medium, and $OR \geq 5.0$ to large effects.

4 Results

4.1 Quantitative Results

Interaction effects supporting the hypotheses for UX were found for aesthetics ($F(22,1) = 4.836$, $p = .039$, $\eta_p^2 = .180$), status ($F(22,1) = 4.683$, $p = .042$, $\eta_p^2 = .176$), and positive emotions ($F(22,1) = 4.349$, $p = .049$, $\eta_p{}^2 = .165$). Neither for usability and usefulness (instrumental qualities), nor for negative emotions significant interactions were detected. Both groups rated usability as well as usefulness very high and negative emotions very low. A main effect for design could be found for usefulness ($F(22,1) = 4.760$, $p = .040$, $\eta_p^2 = .178$), where the flat design was rated more useful than the skeuomorph design in both age groups.

The overall preference of the flat vs. skeuomorph OS version was influenced by age. Fisher's exact test revealed significant differences ($p = .045$, $OR = 6.410$) between the two groups as to the favored design. Elderly users chose the skeuomorph version (83.3%) more often compared to the younger group which preferred flat design (58.3%). In order to explain these effects, personal innovativeness was found to be a significant predictor of these preferences ($F(1,22) = 7.86$, $p = 0.010$, $\eta_p^2 = .263$). Younger respondents showed a larger amount of personal innovativeness which may reflect a mediation effect. No gender effects were observed (Fs < 1, ps > 0.05).

4.2 Qualitative Results

To analyze the qualitative data, the audio recordings were transcribed and sorted into hierarchical categories following the Content Analysis according to Mayring [38].

The frequencies of comments for the most prominent categories of interest are listed in Table 2.

Table 2. Frequencies of comments per category by elderly and young participants.

Categories	Elderly	Young
Reduction to the essential (flat design) is good	1	10
Skeuomorph is easy to understand	6	8
Skeuomorph is more trustworthy because it reminds of the atmosphere in the living room (wooden shelves)	6	2
Flat is more trustworthy because it shows its paces	0	8
Skeuomorph seems to be more sophisticated and is therefore better	3	7
Preference is a matter of habit	5	2

For the icons and interface versions, respondents of both groups stated that they regarded the skeuomorph icons and GUI as easy to understand. Many participants regarded the design preference as a matter of habit and experience with different systems. One respondent from the elderly group said "Flat would be OK as well, if I used it more often. Then I would get accustomed to the flat icons".

Users expressed the wish that "personal" apps, which are linked to precious memories (e.g. notes or a photo gallery), should be more realistic and creative. Common apps without personal significance (e.g. a calculator), however, should be designed in a clean and functional fashion.

5 Discussion

In this study, we investigated how flat and skeuomorph design strategies affect the UX and preferences of young and elderly persons. The results regarding preferences showed that elderly participants more often favored the skeuomorph version, while younger participants more often favored the flat one. According to the CUE model, preferences should coincide with particular differences in UX. Hence, there should be differences in the perceptions of product qualities and emotions between the two age groups which fit their distinct preferences.

Regarding the perception of non-instrumental qualities (e.g. visual aesthetics, status) and positive emotions, the two design strategies affected the two age groups differently; ratings of visual aesthetics, status and positive emotions were higher for the flat design and lower for the skeuomorph design in the younger group compared to the older group. Interaction effects were neither found for instrumental qualities (usability, usefulness), nor for negative emotions.

The effect pattern of the experiment is also in line with the two factor approach of hygiene and motivating factors [39]. Studies have shown that both may affect UX in a certain manner [40, 41]. Usability and usefulness can be characterized as hygiene factors. While their absence leads to dissatisfaction, negative emotions, and withdrawal,

their presence is not sufficient to generate satisfaction, positive emotions or acceptance. On the other hand, motivating factors, such as an aesthetical and innovative design, have the potential to create satisfaction, positive emotions, and acceptance, but their lack does not necessarily lead to negative effects.

Referring to our results, both age groups seem to agree about the hygienic aspects, but not about the motivating factors of the two design versions:

- Neither for usability and usefulness, nor for negative emotions a significant interaction occurred. This appears as reasonable if both instrumental product qualities functioned as hygienic factors because they did not interfere with the solution of the tasks. Indeed, both age groups considered the usability and usefulness of the two versions as so high that the according ratings even suggested a ceiling effect. This result goes in line with comments in the interview; both elderly and younger participants stated that "skeuomorph is easy to understand". At least for our study it seems that the skeuomorph elements and metaphors were not outdated enough to be incomprehensible for members of the younger generation.
- For visual aesthetics, status, and positive emotions an interaction effect was found which matched the difference in preferences between the two age groups. Contrary to the younger participants, the elderly ones rated the UX components these components higher for the skeuomorph version. These different appreciations of the non-instrumental qualities might have acted as motivating factors, which influenced both age groups so that their preferences diverged. Results of the interview give a first hint on some of these factors. Trustworthiness as well as aesthetic aspects, such as sophistication and reduction to the essential, seem to matter in that respect, but more research is required to clarify their role.

As stated before, age is probably not an influence factor per se in this study. Instead, it can be regarded as a placeholder for a number of user characteristics, such as knowledge, habits and tastes, which are typical for persons of the same generation. In particular, age may covary with familiarity. While the younger generation is not well accustomed to many of the analogous objects used in skeuomorph metaphors, the older generation grew up with them. Moreover, younger users of technology might be more flexible and open to innovations compared to elderly ones [42]. This aspect is also reflected by the mediation effect of personal innovativeness in our study. On average, older users take longer to adapt to technological changes [43] - although this effect may vanish over time [11].

To summarize, age related user characteristics might have been responsible for the revealed differences in UX and preferences between both groups. This interpretation is also supported by the qualitative findings in our experiment. Especially, familiarity seems to be a key factor for the differences that occurred. Many older respondents stated that the skeuomorph design appeared to them as better and more trustworthy because they were familiar with the physical objects which served as metaphors in the skeuomorph version. Across both age groups, respondents furthermore agreed that design is a matter of habit. Most users appear to be creatures of habit, which may influence their acceptance and preferences with respect to the two design strategies.

Another qualitative finding concerns the connection between the purpose of an application and its design. Skeuomorph design was especially appreciated for personal, individual applications. For example, respondents preferred more embellished design for applications related to memories (like photo galleries) and minimalistic design for functional apps (like calculators). This finding may prove as important in the debate about both design strategies, since it not only supports the attempt to combine both [27], but also hints at when to employ which of them. When checking specific information (e.g., temperature, time of day), or reading a virtual book, designers should minimize animations, textures, and patterns to a minimum in order to decrease access costs and to improve readability and accuracy [1]. On the other hand, hedonic or non-instrumental applications may benefit from skeuomorph design elements that are aesthetically pleasing and stimulating [25]. To find the "right design" means to select the appropriate design strategy for a use case and a user group. A composition of different elements from both designs may be a good way to combine the advantages and neutralize the disadvantages of flat and skeuomorph strategies [9]. After all, minimalistic design always runs the risk of losing information, which might be necessary to interpret the semantics of a GUI: "Simplification is great if you don't lose information and after all, flat doesn't necessarily imply non-skeuomorphic elements" [13, p. 368].

The results of this study have several implications for research and practice. With respect to the CUE model, age-related user characteristics were found to be vital for UX. To account for the consequences of the aging population and the demographic change, designers of GUIs should take the familiarity and habits of elderly generations explicitly into account. Especially when designing personal applications which might be associated with positive emotional memories, this can help to provide positive experiences and to prevent users' reservation and rejection. To accomplish this, designers must reveal users' real-world and digital metaphors and include them in their concepts. More qualitative and quantitative research is therefore required to discover users' mental representations, semantic interpretations, and personal preferences. User-centered strategies, which feedback such empirical insights into the design process, seem especially suited for this purpose.

Additionally, our results strengthen the idea of a two-sided approach of UX dimensions based on hygiene and motivating factors. This approach should be further distinguished and analyzed in different contexts and use cases. It seems that the motivating element is by far more individual than the hygienic component. Since the "right" design heavily depends on the user group, following the GUI principle "know thy user" seems to be extremely important, especially when it comes to age-related knowledge, habits and preferences. Design strategies must be adjusted to these aspects to ensure satisfaction and positive experiences for all age groups.

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Appendix

Table 3. meCUE questionnaire items (German and English), see also http://www.mecue.de, 7-point-likert scale, German: "lehne völlig ab, lehne ab, lehne eher ab, weder noch, stimme eher zu, stimme zu, stimme völlig zu", English: "strongly disagree, disagree, somewhat disagree, neither agree nor disagree, somewhat agree, agree, strongly agree".

Scale	Original German items [36]	English translation [18]
Usability	1. Das Produkt lässt sich einfach benutzen 2. Es wird schnell klar, wie man das Produkt bedienen muss 3. Die Bedienung des Produkts ist verständlich	1. The product is easy to use 2. It is quickly apparent how to use the product 3. The operating procedures of the product are simple to understand
Usefulness	1. Die Funktionen des Produkts sind genau richtig für meine Ziele 2. Ich halte das Produkt für absolut nützlich 3. Mithilfe des Produkts kann ich meine Ziele erreichen	1. The functions of the product are exactly right for my goals 2. I consider the product extremely useful 3. With the help of this product I will achieve my goals
Aesthetics	1. Das Produkt ist kreativ gestaltet 2. Das Design wirkt attraktiv 3. Das Produkt ist stilvoll	1. The product is creatively designed 2. The design looks attractive 3. The product is stylish
Status	1. Das Produkt verleiht mir ein höheres Ansehen 2. Durch das Produkt werde ich anders wahrgenommen 3. Meine Freunde dürfen ruhig neidisch auf das Produkt sein	1. The product would enhance my standing among peers 2. By using the product, I would be perceived differently 3. My friends could be quietly envious of this product
Positive emotions	1. Das Produkt beschwingt mich 2. Das Produkt entspannt mich 3. Durch das Produkt fühle ich mich ausgeglichen 4. Das Produkt stimmt mich euphorisch 5. Das Produkt beruhigt mich 6. Durch das Produkt fühle ich mich fröhlich	1. The product exhilarates me 2. The product relaxes me 3. The product makes me feel happy 4. The product makes me feel euphoric 5. The product calms me 6. When using this product, I feel cheerful
Negative emotions	1. Das Produkt macht mich müde 2. Das Produkt nervt mich 3. Durch das Produkt fühle ich mich erschöpft 4. Das Produkt frustriert mich 5. Durch das Produkt fühle ich mich passiv 6. Das Produkt verärgert mich	1. The product makes me tired 2. The product annoys me 3. When using this product I feel exhausted 4. The product frustrates me 5. The product makes me feel passive 6. The product angers me

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