Beyond Emoticons: Combining Affect and Cognition in Icon Design

Siné McDougall[1], Irene Reppa[2], Gary Smith[1], and David Playfoot[2]

[1] Bournemouth University, Fern Barrow, Poole, BH12 5BB, UK
[2] Swansea University, Singleton Park, Swansea, SA2 8PP, UK
{smcdougall,i.reppa,gsmith}@bournemouth.ac.uk,
d.playfoot@swan.ac.uk

Abstract. Recently there has been a shift in emphasis from interface usability to interface appeal. Very few studies, however, have examined the link between usability and appeal and evidence regarding the direction of the relationship between the two remains equivocal. This paper examines the nature of the relationships between the usability and aesthetic appeal of icons. The findings from three studies presented here show evidence, not only for the symbiotic relationship between aesthetic preference and performance, but also for the possible causal links between the two. The implications of these findings for interface design and theoretical explanations of usability are discussed.

Keywords: Icon, Affective computing, Aesthetic preference, Performance, Usability.

1 Introduction

Hassenzahl & Tractinsky [1] recently pointed out that 'user experience', a term which previously would have referred exclusively to the usability of an interface, has broadened over the last decade to include our affective response to the interface. They note that 'as technology matured, interactive products became not only more useful and usable, but also fashionable, fascinating things to desire' (p. 91). As a result of this change in focus, research examining the ways in which the appeal of interface can be enhanced has flourished [e.g. 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12]. Despite the growing recognition that enhancing the aesthetic appeal of an interface may be just as important as improving its usability, the nature of the relationship between measures of usability (e.g. accuracy and response time) and appeal is poorly understood. In this paper we argue that knowing more about the nature of this relationship is important if we are to optimize the working relationship between usability and appeal in order to give added value and enhance interface design in a new way.

Research has already shown that usability and appeal are inter-related in a general way. Kuroso & Kashimura [13] found that more aesthetically pleasing designs for an automated teller machine were perceived to be more usable. This finding has since been replicated by Tractinsky and his colleagues who on the basis of their results put forward the idea that '*what is beautiful is usable*' [10, 14]. Hassenzahl's [6] research,

D. Harris (Ed.): Engin. Psychol. and Cog. Ergonomics, HCII 2009, LNAI 5639, pp. 71–80, 2009.

however, challenged this assumption. When he examined the perceived usability of MP3-player skins, he found that perceived usability became a strong determinant of goodness (i.e. satisfaction), particularly after the skins had been used for some time. This raises the possibility that our experience of a usable system affects our perceptions of its appeal - that '*what is usable is beautiful*'. However, it is worth noting that Hassenzahl also drew a distinction between 'goodness', 'beauty' and 'hedonic attributes', each of which had slightly different relationships with perceived usability. What these findings suggest is that the relationships between usability and aesthetics may be a bi-directional one. However, this hypothesis has not yet been tested.

In studies examining aesthetic appeal the choice of stimulus is important. Some earlier researchers advocated the use of works of art or photographs since, they argued, this provided greater ecological validity [15] Others advocated a much more experimental approach using novel stimuli with no pre-existing or obvious emotional valence, maintaining that the use of such stimuli ensured greater experimental validity [16]. More recently research has attempted to combine both bottom-up and top-down approaches [17] and use stimuli which are experimentally tractable while being ecologically valid [e.g., 5, 18]. In the studies which we report here icons were used as stimuli. This is for two reasons. Firstly, icons form a communicative substrate for a wide variety of interfaces. Secondly, as experimental stimuli they are easily controlled and manipulated, not least because their characteristics have been identified and measured [19, 20]. Moreover, the effects of icon characteristics on performance are already well known [e.g., 21, 22].

The three studies reported below demonstrate the complex nature of the relationship between usability (performance) and appeal which is emerging from our laboratory. In the first study, the nature of the relationships between icon characteristics, user performance and aesthetic appeal are examined. The second shows that aesthetic appeal can influence performance (what is beautiful is usable?) and finally the third study shows that our habitual ways of dealing with stimuli influences our perceptions of appeal (what is usable is beautiful?). The theoretical and practical implications of these findings are then discussed. The term aesthetic *appeal* is used when participants' ratings of appeal are the data being considered and *preference* is used when dealing with participants' choices between stimuli.

2 Study 1: Examination of Parallels between Performance and Appeal

2.1 User Performance

The effects of visual complexity, concreteness and familiarity of icons on user performance are well documented and are as follows:-

(i) Users are able to search more quickly for simple, rather than complex, icons in interface arrays (c.f. Figure 1 b and c with d and h) [22, 23, 24]. This is not surprising given what we know about visual search more generally [25].

(ii) Concrete icons can be interpreted more accurately and quickly, particularly when we are learning a new interface (c.f. Figure 1 a and b with c and d) [26, 27]. This is because we can use our knowledge of the everyday world and objects to

deduce what they might mean. However, the extent to which we can deduce icon functions on this basis is limited since many functions cannot be represented concretely while maintaining a good fit between icon and function (c.f. Figure 1a and b).

			
(a) heliport	(b) slow processing	(c) female	(d) rinse
			
(e) sound	(f) loudspeaker connection	(g) biohazard	(h) electric transmission

Fig. 1. Examples of icons

(iii) Our familiarity with what is depicted in the icon appears to be one of the most important determinants of user performance and encapsulates any effects observed for concreteness [21]. This is because even abstract icons can be understood quickly and effectively if we are familiar with the icon. For example, our familiarity with the icon representing 'female' in Figure 1c allows us to identify it more quickly and effectively compared with the icon representing 'slow processing' (Figure 1b). Recently Forsythe, Mulhern & Sawey [28] also have shown that there is a correlation between ratings of icon familiarity and ratings of visual complexity because familiar icons are perceived as being simpler.

Figure 2 summarises findings to date. Familiarity is an important determinant of user performance and encompasses the effects previously observed for concrete icons. Visual complexity also determines user performance via its role in visual search but is also correlated to some extent with icon familiarity since icons appear simpler as we become more familiar with them.

2.2 Ratings of Aesthetic Appeal

Visual complexity, representativeness (concreteness) and familiarity also affect ratings of appeal as follows:-

(i) Stimulus complexity has a significant influence on aesthetic appeal. This holds true for pictures [15], abstract shapes [29] and websites [5, 30].
(ii) Representational pictures (i.e. those which depict concrete objects) are preferred to abstract ones [31, 32].
(iii) Zajonc [33] and others have shown that even when we see objects only briefly, the appeal of these stimuli is increased relative to stimuli which have not previously been seen and this appeal grows as we grow more familiar with them [34].

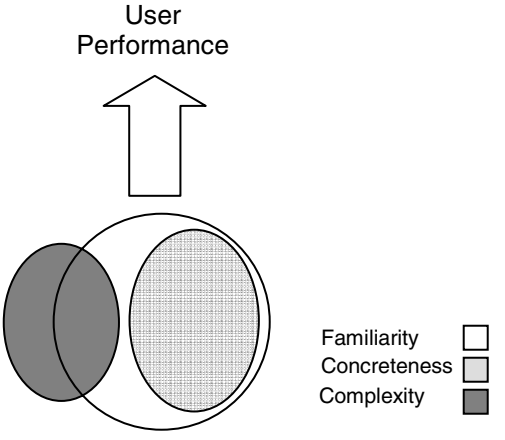

Fig. 2. Relationships between icon characteristics and performance

Study 1 examined these remarkable parallels between the factors that determine performance and aesthetic appeal in more detail. Ratings of aesthetic appeal were obtained for a large corpus of 239 icons for which subjective ratings of complexity, concreteness and familiarity had already been obtained (thus providing a measure of each of these icon characteristics, [19]). Forty participants[1] were asked to rate the appeal of the icons on a 1-5 scale (1=really dislike, 5=really like). Our expectation was that if appeal is truly related to performance we would expect that relationships between icon characteristics and performance would be the same as for user performance as in Figure 2 above.

In accordance with previous findings, simple icons received higher appeal ratings than complex icons, concrete icons received higher ratings than abstract icons, and familiar icons were more appealing than unfamiliar icons. Regression analyses were carried out to examine predictive relationships between icon characteristics and appeal in more detail. These analyses revealed that familiarity, concreteness and visual complexity predict aesthetic appeal *in the same intricate manner as that observed for user performance in Figure 2 above*. Firstly, familiarity was the primary predictor of aesthetic appeal. Secondly, although icon concreteness was a strong predictor of appeal, it did not significantly predict variance in appeal once the effects of familiarity had been accounted for. Finally, visual complexity independently predicted significant amounts of the variance observed in aesthetic appeal, but its role in determining appeal also overlapped to some extent with familiarity.

3 Study 2: Is It Usable *Because* It Is Beautiful?

Study 1 illustrated the complex nature of the symbiotic relationship between usability and appeal, expanding our knowledge from previous research which has suggested a

[1] Participants in the studies reported here were undergraduate or graduate students at the universities of Swansea and Bournemouth.

general correlation between appeal and usability. However, it did not establish a *causal* link between appeal and user performance. In Study 2 we set out to examine whether or not there was a causal relationship and, if so, what form that might take.

In this study the visual complexity and aesthetic appeal of icons was varied orthogonally. Four sets of icons were created: simple icons which were either appealing or non-appealing (see Figure 1, e and f) and complex icons which were either appealing or non-appealing (see Figure 1, g and h). In addition, all 4 sets were matched on the basis of other icon characteristics (i.e. concreteness and familiarity). Fifteen participants were required to search for icons in an array in a task designed to mimic search for symbols on an interface such as finding icons in cluttered computer desktop displays or selecting icons in software packages (see Figure 3).

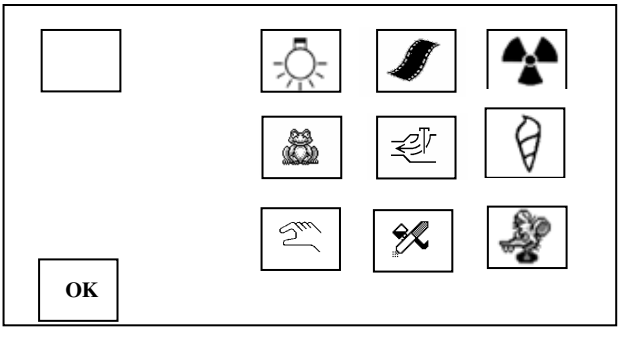

Fig. 3. Example of display in visual search task

On the basis of previous research, we might have expected search times to be optimal when icons are both simple and appealing (i.e. they have additive effects). However, it was equally possible that the effect of appeal could be contingent on visual complexity (i.e. the beneficial effect of appeal on performance would only be apparent *either* when icons were simple *or* when they were complex, not both).

Figure 4 shows that, in accordance with previous research, search times were faster for simple icons. However, search times for appealing and non-appealing simple icons did not differ. In contrast, response times to appealing complex icons were significantly faster than when they were not appealing. Performance was therefore contingent on the visual complexity of the icon.

These findings are not entirely surprising given what we know of visual search. In visual search arrays, simple icons are more likely to 'pop-out' in a visual display, as they are easier to process (i.e., due to fewer features present in the stimulus). In this case any effect of aesthetic appeal is likely to be overridden by the 'pop-out' effect. In contrast, complex icons are less likely to 'pop-out' in a search array (i.e., due to greater number of visual features present in the stimulus). It is only in this case that aesthetic appeal has an effect on search performance, reducing search times for complex icons with high aesthetic appeal.

This study shows that aesthetic appeal directly affects user performance (i.e. it is usable because it is beautiful) but that it is a contingent, rather than a simple, relationship.

Simple icons are usable, irrespective of appeal, at least where tasks require visual search. Complex icons are less usable, but the effects of visual complexity can be ameliorated if the icon is appealing. Again, this study serves to illustrate the need for a more detailed knowledge of the general relationships previously observed in order to be able to apply them effectively to interface design.

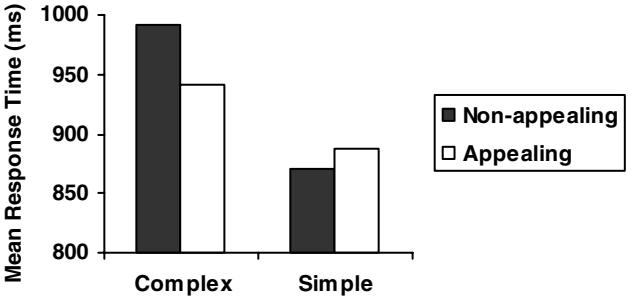

Fig. 4. The effect of visual complexity and aesthetic appeal on performance

4 Study 3: Is It Beautiful *Because* It Is Usable?

This study also illustrates the subtle factors affecting the relationship between user performance and appeal. In contrast to Study 2, this study examined whether skills which are likely to affect usability affect our perceptions of their appeal, i.e. what is usable is beautiful.

Recent research has shown that aesthetic preferences can be affected by our habitual direction of reading, i.e. right-to-left for readers of Arabic and Hebrew or left-to-right for readers of English and other European languages. Chokron & De Agostini [35] recently found that French, left-to-right, readers preferred pictures which had most of their content on the right while Israeli Hebrew, right-to-left, readers preferred pictures whose content was primarily on the left. Similar findings were reported by Heath et al [36] although they also found that preferences were dependent on the extent to which individuals read in only one language. The tendency to have a rightward bias in English readers diminished with exposure to Arabic. The aim of Study 3 was to determine if (a) the directional bias in appeal for picture content in previous studies would be present when icon appeal was considered and (b) the influence of icon characteristics differed depending on the orthography which individuals habitually used. Thirty six right-handed participants took part in this study; half the participants were right-to-left readers (Arabic) and the other half were left-to-right readers (English).

Participants were presented with icons in pairs which were mirror-images of one another. One set of icons had a left-right emphasis and the other had a right-left emphasis. For example, Figure 1a shows a 'heliport' icon with right emphasis while Figure 1b shows a 'slow processing' icon with left emphasis. Each individual icon would be shown paired with its mirror-image (e.g. the 'heliport' icon flipped to the left). Participants were asked to state which one they preferred. Our findings are

illustrated in Figure 5. The pattern of results was similar to Heath et al.(2005). English readers significantly preferred icons with right emphasis in accordance with their reading direction. Arabic readers, however, did not show any significant preference for either left or right picture emphasis and this appears to have been the result of the fact that our participants were bilingual Arabic-English speakers and habitually read in both directions. These findings suggest that the influences on aesthetic preference for interfaces are very subtle. While this study could be taken as evidence of the idea that 'what is usable is beautiful', some important caveats need to be borne in mind when reaching conclusions. The first is that reading is a skill and is not a direct measure of usability – we have assumed that for English readers, icons with right emphasis are more usable but this needs to be demonstrated directly. The second is that this paradigm emphasizes differences in appeal for stimuli which differ in left-right emphasis and are therefore asymmetrical. Many icons are symmetrical for good reason, since they are easier to process, represent man-made objects which are typically symmetrical, and are more likely to be found appealing [37, 38].

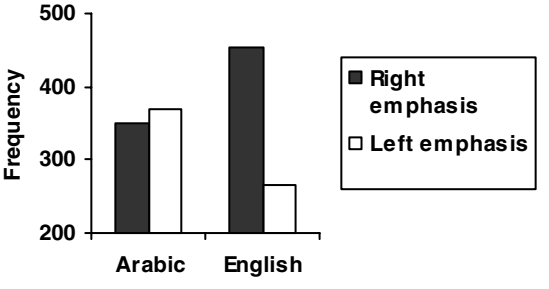

Fig. 5. Frequency of preference for left and right emphasis pictures in Arabic and English readers

5 Discussion

5.1 Theoretical Explanations

The current studies demonstrate that usability-aesthetics relationships operate in both a feed-forward and feed-backward manner, i.e. they are bi-directional. Is there a theoretical account which can bring these and other existing findings together? One possibility is the *perceptual fluency hypothesis* which postulates the stimuli we have previously encountered are processed perceptually more effectively and quickly [39]. This perceptual fluency is subsequently (mis)attributed to greater liking. Recently Reber et al revised this account on the basis of cultural influences on taste and proposed a *processing fluency* account [40]. This proposed that (i) stimuli differ in the fluency with which they can be processed (ii) fluency itself is hedonically marked (iii) processing fluency feeds into judgments of aesthetic appeal and (iv) that the impact of fluency is moderated by expectations and attributions based on experience. This certainly provides a dynamic, rather than static, explanation of aesthetic appeal and takes account of experience and task demands as well as stimulus characteristics. However,

it assumes that judgments of appeal *follow* performance, while our research suggests that this relationship is bi-directional. We therefore propose that, while Reber et al.'s unidirectional framework helps to bring together many of the disparate findings reported to date, our findings suggest that ratings of appeal emerge out of ongoing processing and that the timeline for 'hedonic marking' may reflect a bi-directional relationship between performance and appeal. It is also important to take account of the possibility that under certain circumstances the close relationship between appeal and performance may break down. For example, where usability is paramount, appeal may not be so closely correlated with performance (e.g. in air traffic control displays task demands may determine the closeness of the relationship between usability and appeal).

5.2 Practical Implications

At a practical level our findings have a number of implications:-

1. Our findings challenge both researchers and interface designers to take account of the strong links observed between user performance and appeal, and that icon characteristics which users may not be consciously aware of, may influence the appeal of the interface and subsequent usability.
2. The findings of Study 2 suggest that if complex icons are necessary, as in some cockpit displays for example, one way to mitigate the increased search time for complex icons is to maximize aesthetic appeal.
3. Study 3 showed that users' skills and habitual modes of processing, such as the directional in which they read, can influence perceptions of appeal. This may be particularly important for website design.

References

1. Hassenzahl, M., Tractinsky, N.: User experience – a research agenda. Behaviour & Information Technology 25, 91–97 (2006)
2. Bauerly, M., Liu, Y.: Computational modeling and experimental investigation of the effects of compositional elements on interface and design aesthetics. In: Proceedings of the 8th Annual International Conference on Industrial Engineering – Theory, Applications and Practice (2008)
3. Bauerly, M., Liu, Y.: Development and validation of a symmetry metric for interface aesthetics. In: Proceedings of the 49th Annual Meeting of the Human Factors and Ergonomics Society (2005)
4. Bauerly, M., Liu, Y.: Computational modeling and experimental investigation of effects of compositional elements on interface and design aesthetics. International Journal of Human-Computer Studies 64, 670–682 (2006)
5. Bauerly, M., Liu, Y.: Effects of symmetry and compositional elements on interface design and aesthetics. International Journal of Human-Computer Interaction 24, 257–267 (2008)
6. Hassenzahl, M.: Emtions can be quite ephemeral: We cannot design them. Interactions 11, 46–48 (2004)
7. Lindgaard, G., Dudek, C.: What is this evasive beast we call user satisfaction? Interacting with Computers 15, 429–452 (2003)

8. Lindgaard, G., Fernandes, G., Dudek, C., Brown, J.: Attention web designers: You have 50 milliseconds to make a good first impression. Behaviour & Information Technology 25, 115–126 (2006)
9. Han, S.H., Hong, S.W.: A systematic approach for coupling user satisfaction with product design. Ergonomics 46, 1441–1461 (2003)
10. Tractinsky, N., Katz, A.S., Ikar, D.: What is beautiful is usable. Interacting with Computers 13, 127–145 (2000)
11. Tractinsky, N., Cokhavi, A., Kirschenbaum, M., Sharfi, T.: Evaluating the consitency of immediate perceptions of web pages. International Journal of Human-Computer Studies 64, 1071–1083 (2006)
12. Zhang, P., von Dran, G., Blake, P., Pipthsukunt, V.: Important design feature in different website domains: An empirical study of user perceptions. e-Service Journal 1(1) (2001)
13. Kurosu, M., Kashimura, K.: Apparent usability vs. inherent usability. In: CHI 1995 Conference Companion, pp. 292–293 (1995)
14. Tractinsky, N.: A few notes on the study of beauty in HCI. Human-Computer Interaction 19, 351–357 (2004)
15. Berlyne, D.E.: Studies in the new experimental aesthetics. Hemisphere, Washington (1974)
16. Raymond, J.E., Fenske, M.J., Tavassoli, T.T.: Selective attention determines emotional responses to novel visual stimuli. Psychological Science 14, 537–542 (2000)
17. Zeki, S.: The splendours and miseries of the brain: Love, creativity and the pursuit of human happiness. Wiley & Sons, Chichester (2009)
18. Fang, X., Singh, S., Ahluwalia, R.: An examination of different explanations for the mere exposure effect. Journal of Consumer Research 34, 97 (2007)
19. McDougall, S., Curry, M.B., de Bruijn, O.: Measuring symbol and icon characteristics: Norms for concreteness, complexity, meaningfulness, familiarity and semantic distance for 239 symbols. Behavior Research Methods 31, 487–519 (1999)
20. Forsythe, A., Sheehy, N., Sawey, M.: Measuring icon complexity: An automated analysis. Behavior Research Methods, Instruments and Computers 35, 334–342 (2003)
21. Isherwood, S., McDougall, S., Curry, M.: Icon identification in context: The changing role of icon characteristics with user experience. Human Factors 49, 465–476 (2007)
22. McDougall, S., de Bruijn, O., Curry, M.: Exploring the effects of icon characteristics on user performance: The role of concreteness, complexity and distinctiveness. Journal of Experimental Psychology: Applied 6, 291–306 (2000)
23. Byrne, M.D.: Using icons to find documents: Simplicity is critical. In: Proceedings of INTERCHI 1993, pp. 446–453 (1993)
24. Scott, D.: Visual search in modern human-computer interfaces. Behaviour and Information Technology 12, 174–189 (1993)
25. Quinlan, P.T.: Visual feature integration theory: Past, present, and future. Psychological Bulletin 129, 643–673 (2003)
26. Green, A.J.K., Barnard, P.J.: Iconic interfacing: The role of icon distinctiveness and fixed or variable screen locations. In: Diaper, D., et al. (eds.) Human-computer interaction – Interact 1990. Elsevier, North-Holland (1990)
27. Rogers, Y., Oborne, D.J.: Pictorial communication of abstract verbs in related to human-computer interaction. British Journal of Psychology 78, 99–112 (1987)
28. Forsythe, A., Mulhern, G., Sawey, M.: Confounds in pictorial sets: the role of complexity and familiarity in basic-level picture processing. Behavior Research Methods 40, 116–129 (2008)

29. Jacobsen, T., Hofel, L.: Aesthetic judgments of novel graphic patterns: Analyses of individual judgments. Perceptual & Motor Skills 95, 755–766 (2002)
30. Lavie, T., Tractinsky, N.: Assessing dimensions of perceived visual aesthetics of web sites. International Journal of Human-Computer Studies 60, 269–298 (2004)
31. Vartanian, O., Goel, V.: Neuroanatomical correlates of aesthetic preferences for paintings. Neuroreport 15, 893–897 (2004)
32. Kawabata, H., Zeki, S.: Neural correlates of beauty. Journal of Neurophysiology 91, 1699–1705 (2004)
33. Zajonc, R.B.: Attitudinal effects of mere exposure. Journal of Personality & Social Psychology Monographs 9, 1–27 (1968)
34. Bornstein, R.F.: Exposure and affect: Overview and meta-analysis of research, 1968-1987. Psychological Bulletin 106, 265–289 (1989)
35. Chokron, S., De Agostini, M.: Reading habits influence aesthetic preference. Cognitive Brain Research 10, 45–49 (2000)
36. Heath, R., Mahmasanni, O., Rouhana, A., Nassif, N.: Comparison of aesthetic preferences among Roman and Arabic script readers Laterality: Asymmetries of Body, Brain, and Cognition, vol. 10, pp. 399–411 (2005)
37. Arnheim, R.: Art and visual perception: The new version. University of California Press, Berkeley (1974)
38. Humphrey, D.: Preferences in symmetries and symmetries in drawings: Asymmetries between ages and sexes. Empirical Studies of the Arts 15, 41–60 (1997)
39. Reber, R., Winkielman, P., Schwarz, N.: Effects of perceptual fluency on affective judgments. Psychological Science 9, 45–48 (1998)
40. Reber, R., Schwarz, N., Winkielman, P.: Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? Personality and Social Psychology 8, 364–382 (2004)