Ease of Icon Processing Can Predict Icon Appeal

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Abstract. Correlations between subjective ratings of interface usability and appeal have been frequently reported. This study examined the possibility that the relationship between usability and appeal are underpinned by implicit perceptions of ease of processing which act as a heuristic in making judgments of appeal. Ease of processing was manipulated by varying the amount of experience participants gained with icons in a search task prior to judging appeal, as well as varying the familiarity and visual complexity of the icons presented. These manipulations systematically affected response times in the search task (an *objective* measure of usability). The effects observed in appeal judgments followed the *same* pattern as for search times, demonstrating that ease of processing predicts judgments of appeal. This suggests that our understanding of interface appeal needs to be predicated on an appreciation of the factors affecting the ease with which information on an interface is processed.

Keywords: Interface appeal; usability; processing fluency; icons.

1 Introduction

1.1 The Relationship between Usability and Appeal

Interface usability typically refers to the ease with which an interface can be learned and how swiftly and accurately it can be used [1,2]. It is now recognized that enhancing the aesthetic appeal of an interface may be just as important as improving its usability [3]. Recent research has therefore often focused on how interface appeal can be enhanced [4-8].

A number of studies have observed a relationship between ratings of perceived usability and ratings of aesthetic appeal. These studies have typically obtained ratings of usability and ratings of appeal for interfaces such as websites, MP3 players, or mobile phones and analyzed the correlation between ratings [9-11]. In a recent review Hassenzahl & Monk [12] found that correlations between ratings of usability and appeal are commonly reported and that the strength of the correlation varied in accordance with the context, the nature of the interface, and the task demands.

1.2 Using Ease of Processing as a Heuristic to Judge Appeal

The relationship between usability and appeal may be explained by *ease of processing* accounts of aesthetic appeal. The ease of processing of a stimulus has been suggested

M. Kurosu (Ed.): Human-Computer Interaction, Part I, HCII 2013, LNCS 8004, pp. 575–584, 2013.

as a potential general heuristic which may influence judgments of appeal [13, 14]. Alter & Oppenheimer [13] argued that the ease with which stimuli can be processed generates a corresponding *fluency experience*. It is this fluency experience which then acts as a heuristic in determining judgments of appeal.

This rationale can be used to explain the observed correlation between interface usability and appeal. If interfaces are easy to use (i.e. facilitate ease of processing and generate a corresponding fluency experience) then they will be judged as more appealing. Conversely, if interfaces are difficult to use (i.e. are difficult to process, generating a poor fluency experience) then they will be judged as less appealing.

1.3 Factors Influencing Ease of Processing

The aim of the current study was to examine the hypothesis that ease of processing can indeed influence judgments of appeal, using icons as stimuli. Ease of processing was measured objectively - rather than subjectively - by measuring performance during a search task. The search task, in which participants were asked to search for icons in an array, was designed to be analogous to the everyday task of searching for icons on an interface. Ease of processing was manipulated experimentally by varying (a) the amount of experience users gained with icons before rating appeal and (b) the nature of the icons presented in the search task (i.e. their familiarity and visual complexity).

Experience with the Icons. Icons were presented to participants over 9 blocks of search trials. Ratings of appeal were obtained after the first and ninth blocks of trials. It was expected that ease of processing, and hence ratings of appeal, would improve as they gained experience with the icons over blocks of trials.

Men's restroom (a) | Zoom (b) | Female (c) | Fast processing (d)

Fig. 1. Examples of icons

Familiarity with the Icon. Familiarity is one of the most important predictors of speed and accuracy of icon processing [15, 16]. For example, our familiarity with the icon for men's restroom allows us to search for it more quickly in an array in comparison to an icon representing the 'zoom' function on cameras (c.f. Fig. 1a and b). This cannot be accounted for simply because one icon is pictorial and the other is not: our familiarity with the abstract icon representing 'female' (Fig. 1c) allows us to identify it more quickly and effectively compared with the pictorial icon representing 'fast processing' which is not familiar (Fig.1d; see [15]).

On the basis of previous research it was therefore expected that familiar icons would be found faster in the search arrays in comparison to unfamiliar icons. As a

result, participants' fluency experiences between these types of icons would differ resulting in familiar icons being rated more positively for appeal than unfamiliar icons.

Visual Complexity of the Icon. The visual complexity of an icon or picture can be measured in a number of ways but generally can be taken to refer to the level of intricacy or detail in a stimulus [c.f., 17-19]. Simple icons can enhance performance because they can be discriminated more easily in arrays [20] and are located more easily, or pop-out, in visual search [20-23]. It was expected that simple icons would be regarded as more appealing than complex icons because of the relative ease with which they may be processed.

Prior familiarity and visual complexity of the icons were varied orthogonally (see Figure 2). Icons were either simple or complex, familiar or unfamiliar.

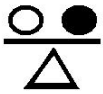
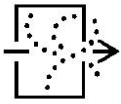
	Visual Complexity	
Familiarity	Simple	Complex
Familiar		
	Picnic Area	Risk of explosion
Unfamiliar		
	Balance	Rinse

Fig. 2. Types of icons presented in the visual search task which varied orthogonally on familiarity and visual complexity

1.4 Controlling Icon Appeal

Importantly, the appeal of icons *prior* to the experiments was held constant across all 4 types of icon presented to participants. This is because both the visual complexity and our familiarity with a stimulus are known to affect judgments of appeal.

Familiarity with the Icon. Stimulus familiarity is an important predictor of appeal judgments with familiar stimuli rated more highly than unfamiliar ones and correlates significantly with ratings of appeal [24-30].

Visual Complexity of the Icon. Similarly, visually simple stimuli tend to be preferred or rated more highly on appeal than visually complex ones [26, 31, 32].

Mean ratings of appeal obtained previously from an icon corpus were therefore used to ensure that icons in all four experimental conditions shown in Fig. 2 did not differ in appeal (see Materials for details). This meant that differences in appeal which emerged during the study could be attributed to differences in ease of processing rather than merely being the result of prior differences between experimental materials.

To summarize, if ease of processing during the search task determines perceptions of appeal we should expect the following:-

(a) If response times are lower for simple and familiar icons then ratings of appeal will be higher
(b) Ratings of appeal will increase as we gain experience with icons.

2 Method

2.1 Participants

Forty-two undergraduate and postgraduate students from Bournemouth University took part in this experiment. Twenty-one participants provided ratings of appeal after completing 1 block of experimental trials. Their mean age was 20.83 years (12 females, 9 males). Twenty-one participants provided ratings of appeal after completing 9 blocks of experimental trials. There mean age was 22.33 years (13 females, 8 males). Each participant received £12 or course credits for taking part in the study.

2.2 Procedure

Participants carried out a search task designed to be analogous to searching for icons on an interface. They searched for a pre-determined target icon among an array of nine icons. Participants were initially shown the target for 2 seconds and, once it disappeared from the screen, an OK button appeared. Participants then pressed the OK button to display the search array and used the mouse to click as quickly as possible on the icon they had seen where it was displayed in the array. Once participants had clicked on an icon in the array, the array disappeared and the next experimental trial began.

There were 9 blocks of trials, with 40 trials per block. In each block, 40 icons were search targets, 10 icons of each icon type shown in Figure 2. Appeal judgments were obtained from two separate experimental groups, one providing ratings at block 1, the other at block 9.

Ease of processing was measured as the time taken by participants to search for an icon in an array (a task similar to searching for icons on an interface). Participants were asked to rate icons on a 1-5 scale (from really dislike to really like) *either* after completing 1 block of experimental trials *or* after completing 9 blocks of experimental trials.

2.3 Design

Participants completed two tasks, a search task and a rating task. The search task was based on a repeated-measures design manipulating three within-participants independent variables. These were icon familiarity with 2 levels (familiar and unfamiliar), icon complexity with 2 levels (simple and complex), and blocks of trials with 9 levels (Blocks 1-9). The combination of icon familiarity and icon complexity gave rise to four icon types which were presented in each of 9 blocks of trials. The dependent measure for the search task was the response time taken to find the target icon in an array of icons.

In the rating task there were also three independent variables: icon familiarity (familiar and unfamiliar) and icon complexity (simple and complex) were within-participant variables (as in the search task), but blocks of trials was manipulated between-participants and it had only two levels (block 1 and block 9). The dependent measure for the ratings task was mean appeal rating per condition per block.

2.4 Materials

Icons were selected from a corpus of 239 icons rated for familiarity, complexity and appeal [26, 33]. As shown in Fig. 2, 40 icons were presented in the visual search trials which varied orthogonally in their familiarity and visual complexity: they were (a) 10 familiar and complex icons, (b) 10 familiar and simple icons, (c) 10 unfamiliar and complex, and (d) 10 unfamiliar and simple icons. A further 60 icons were used in the ratings booklet which participants were asked to complete after blocks 1 and 9. These included a matching set of 40 icons of the same 4 types which participants had not seen before, as well as a set of 20 previously unseen 'neutral' stimuli whose familiarity and complexity fell in the mid-range. Data analyses reported here refer only to the 40 icons shown to participants.

A series of one-way analyses of variance followed by Newman-Keuls comparisons was conducted to ensure that ratings differed in accordance with the requirements of each experimental condition. Ratings of familiarity differed significantly, $F(3,36) = 25.20$, $p < .001$. Newman-Keuls comparisons revealed that familiar simple and complex icons had significantly higher familiarity ratings than unfamiliar icons; M(complex/familiar)=3.41, M(simple/familiar)=3.61, M(complex/unfamiliar)=2.01, M(simple/unfamiliar)=2.04. Ratings of visual complexity also differed significantly, $F(3,36) = 63.88$, $p < .001$. Newman-Keuls comparisons revealed that complex familiar and unfamiliar icons had significantly higher complexity ratings than simple icons; M(complex/familiar)=3.44, M(complex/unfamiliar)=3.47, M(simple/familiar)=2.00, M(simple/unfamiliar)=2.02. Ratings of icon appeal did not differ significantly, $F(3,36) = 2.69$, $p > .05$; M(complex/familiar)=2.96, M(complex/unfamiliar)=2.68, M(simple/familiar)=3.29, M(simple/unfamiliar)=2.90.

3 Results

3.1 Response Times

An analysis of variance was conducted to examine the effects of experience (blocks of trials 1-9), icon familiarity (familiar vs. unfamiliar) and icon complexity (simple vs. complex) on participants' response times.

As expected, response times reduced as participants gained experience with icons in the search task, $F(8,320) = 13.05$, $p < .001$, M(block 1)=1239 ms, M(block9)=1101 ms. Response times were faster for familiar in comparison to unfamiliar icons, $F(1,40) = 79.69$, $p < .001$, and faster for simple in comparison to complex icons, $F(1,40) = 91.40$, $p < .001$. An interaction between familiarity and complexity was observed, $F(1,40) = 10.47$, $p = .002$. This interaction is shown in Figure 3a. Further analyses revealed that the difference in response times between familiar and unfamiliar icons was greater for simple icons than for complex icons, $t(41) = 3.27$, $p = .002$. No other interactions were significant.

3.2 Ratings of Appeal

A similar analysis of variance was conducted to examine the effects of experience (block 1 vs. block 9), icon familiarity (familiar vs. unfamiliar) and icon complexity (simple vs. complex) on participants' ratings of appeal.

There was a significant main effect of blocks of trials, $F(1,40) = 5.46$, $p < .001$. Participants who had gained more experience with the icons gave them higher ratings of appeal, M(block 9)=3.06, than those with less experience of the icons, M(block 1)=2.81. Ratings were higher for familiar than for unfamiliar icons, $F(1,40) = 17.55$, $p < .001$, and for simple as opposed to complex icons, $F(1,40) = 8.87$, $p < .001$. Furthermore, there was a significant interaction between familiarity and complexity, $F(1,40) = 4.77$, $p = .035$ (see Figure 3b). A paired t-test was carried out to examine the interaction further and showed that the difference in ratings between familiar and unfamiliar icons was greater for simple icons than for complex icons, $t(41) = 2.17$, $p = .035$. No other interactions were significant.

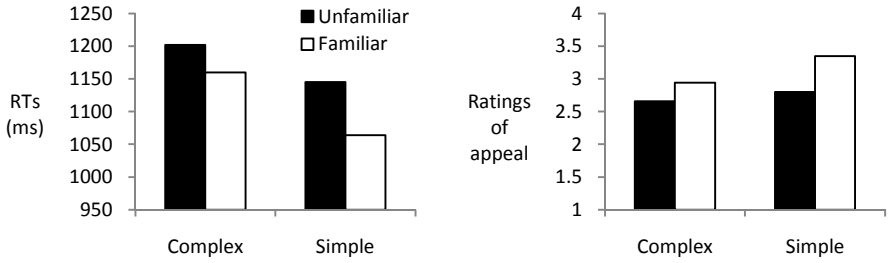


Fig. 3. Interactions between icon familiarity and complexity for (a) response times in the search task and (b) ratings of appeal

The findings for ratings of appeal mirror those found for response times. Because participants were not given any information about the visual complexity or familiarity of icons, it is difficult to explain these findings in terms of explicit awareness. This is particularly true of the interaction observed between familiarity and complexity. Participants' judgments of appeal appeared to be determined by an implicit awareness of the ease with which items had been processed as measured the time they took to respond in the search task. Furthermore, despite the fact that ratings were obtained from two participant groups *either* after 1 *or* 9 blocks of experimental trials, ratings of appeal were higher at block 9 than block 1.

4 Discussion

In their recent review of the literature examining the role of processing fluency on our judgments, Alter & Oppenheimer [13] stated the following:

> Processing fluency, or the subjective experience of ease with which people process information, reliably influences people's judgments across a broad range of social dimensions. Experimenters have manipulated processing fluency using a vast array of techniques, which, despite their diversity, produce remarkably similar judgmental consequences. For example, people similarly judge stimuli that are semantically primed (conceptual fluency), visually clear (perceptual fluency), and phonologically simple (linguistic fluency) as more true than their less fluent counterparts. ... Because every cognition falls along a continuum from effortless to demanding and generates a corresponding fluency experience, [the authors argue that] fluency is a ubiquitous metacognitive cue in reasoning and social judgment. p. 219

Given the diversity and extent of research examining how fluency affects cognition, it is perhaps surprising that it has not informed our understanding of individuals' judgments about interfaces, particularly given the current focus on interface appeal.

4.1 Usability, Processing Fluency, and Appeal

The aim of the current research was to explore the possibility that processing fluency could be used as a way of explaining the relationship between perceived usability and appeal that has been observed in a number of studies. Rather than relying on subjective measures of usability (i.e. ratings of perceived ease of use), response time in a search task was used as the index of ease of processing. The search task was designed to be analogous to our everyday search for icons on interfaces.

The results showed that the factors affecting ease of processing – experience and the familiarity and complexity of the icons – can predict judgments of appeal. Specifically, icon familiarity and complexity influenced both response times and appeal ratings. Most surprisingly, familiarity interacted with complexity in the same manner for both response times and appeal ratings (Fig. 3). In other words, appeal ratings for icons that were *pre-experimentally equated in terms of appeal*, followed the exact same pattern as the pattern of performance. This demonstrated that implicit awareness of ease of processing was driving judgments of appeal.

At a practical level, we therefore suggest that in order to optimize interface design, the current focus on interface appeal needs to be closely tied to a sound understanding of the factors influencing speed and efficacy of responding to interfaces, i.e. ease of processing.

4.2 Fluency Discounting in Judgments of Appeal – Future Research

While the current findings suggest that processing fluency can be a strong driver of appeal judgments, evidence to date suggests that fluency may be discounted in favor of other, more salient, cues for decision making [e.g. 34, 35]. Current research in our laboratory is focussing on what cues might be used to *decouple* ease of processing information from appeal judgments. It seems likely that this will be relatively nuanced and situation specific and may well be in accordance with the pattern of correlations found by Hassenzahl and Monk [12] in their recent review of correlations between ratings of usability and appeal.

Acknowledgements. We gratefully acknowledge the help in gathering data for this study which we had from Josh Denness, Jessica Emmett and Henrik Waerland.

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